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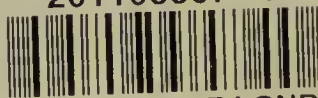
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ELEMENTS
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PHYSIOLOGY.

BY
K. A. RUDOLPHI, M.D.

*PROFESSOR OF MEDICINE, AND MEMBER OF THE ROYAL ACADEMY OF SCIENCES
OF BERLIN.*

TRANSLATED FROM THE GERMAN,
BY WILLIAM DUNBAR HOW, M.D.

IN THREE VOLUMES.

VOLUME I.

LONDON:

PRINTED FOR LONGMAN, HURST, REES, ORME, BROWN,
AND GREEN;
PATERNOSTER-ROW.

1825.

736864
TOMH

D. Cameron, Printer.



TO

WILLIAM LAWRENCE, F. R. S.

PROFESSOR OF SURGERY AND ANATOMY TO THE ROYAL COLLEGE OF SURGEONS OF
LONDON ; SURGEON TO ST. BARTHOLOMEW'S HOSPITAL, &c. &c. &c.

THE

FOLLOWING WORK

IS INSCRIBED,

AS

A TESTIMONY OF RESPECT AND ESTEEM,

FOR

HIS SUCCESSFUL EXERTIONS

IN THE

CAUSE OF SCIENCE,

BY

HIS VERY OBEDIENT SERVANT,

THE TRANSLATOR.

THE UNIVERSITY OF CHICAGO

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ADVERTISEMENT.

THE present volume, being the first of three, contains the First Part, or GENERAL PHYSIOLOGY complete. The second and third volumes will be published in the course of the ensuing summer.

APPENDIX

The following table shows the results of the
analysis of the soil in the various
localities. The results are given in
the form of percentages of the total
weight.

TRANSLATOR'S PREFACE.

THE true principles of Physiology are the only base on which pathological opinions can claim a sure foundation ; and it is certain, that an attempt to gain an accurate knowledge of the causes and action of disease, is vain and futile, unless it be assisted by a previous accurate conception of the healthful functions. This science, therefore, which is of so much importance in enabling the physician to explain the numerous phenomena of disease, has of later years gained that attention from the medical inquirer which its utility so highly merits ; and the number of elementary physiological works which have appeared in the world since the time of Haller*, will shew the assiduity with which it has on every side been cultivated. But it frequently unfortunately happens, that the most intelligent writers are led aside from the more important truths and principles of the science, into a kind of speculative inquiry. An abstract or purely speculative work, intended

* Introduction, vide 16. et seq.

solely as such, is, notwithstanding, of the greatest utility, as it is by this means, that the experimentalist is provided with materials and suggestions on certain subjects, which may have been previously neglected. But it is only when these have been established by the latter, that they can, with propriety, be admitted into an *elementary work*; in which all the abstract and speculative philosophising, which had the merit of facilitating the progress of the experimentalist to a more extended connexion of the subject, is not denied, but cannot be recorded in detail.

The almost insuperable difficulties which have ever attended the compilation of an elementary work on Physiology, are increasing almost daily. There are few authors who are not engaged in some favourite hypothesis, and thus the facts which come under their observation are seen through a false and deceitful medium. But we expect from the person who undertakes a work of this description, that he should be able to discriminate between that which is true, and founded on the proven principles of philosophy, and that which is false, or the result solely of a luxuriant imagination; he must erect and establish science on solid principles, that it may accord both with nature and with truth, and afford a firm foundation to the healing art. It is not his duty to propose a mere imaginary principle on which to erect the firm dogmata of science; it must be philosophical—either by experiment or induction, instead of giving space to hypothetical details, to satisfy that desire so pernicious to science—of attempting to exalt the sphere and ingenuity of human reason, to a height which it will never attain. But he should deliver it

to the public as a well arranged and digested collection of all that has been known since the earliest days of its cultivation up to the present time, by the collective labours of its best professors and writers : which the industry of the ancients may have detected, and the subtlety of the moderns improved, until it has attained its present rank in the list of the other branches of medical science.

A science is a collection of facts, of observations, of particular truths, of principles, of general results, and of opinions, combined together, and legitimately deduced from such facts, observations, and experiments.

It is the application of information, and the proper arrangement of facts, their application, comparison, and the inferences to be drawn from such comparison, that constitute the value of the scientific information, not the mere aggregate of uninterpreted phenomena, nor the irregular catalogue of unclassified experiments. Without this discriminating principle and love for truth, unless the general principles of the science be the immediate and accurate deduction from facts, they are nothing more than mere probabilities which lead us into a waste of hypothetical absurdities. In this condition stood formerly the science of Physiology, unconnected with, and inapplicable to, the study of the other departments of medicine, or to use the words of Treviranus, "it was "insulated and detached like the pyramids in the "Arabian deserts,"—a confused collection of individual speculations.

But since the lights of anatomy, which from the time of Vesalius have shone so conspicuously on the study of medicine, have dissipated the clouds which ob-

structed our view into the secrets of organisation, Physiology has been no less remarkable in its progress towards perfection; and the combination of these two has had the most beneficial influence on the theory of disease. We are no longer occupied with universal theories, or with one which, holding out an apparent advantage over its predecessor, is accepted, but only to await a similar destination.

We have now a store of maxims, deduced from fundamental truths, and consecutively combined to a whole;—a stock of information, or a judicious collection of facts, accurately arranged, and scientifically examined, which contribute more to the benefit of the student, than the most elaborate compilations of matter unhappily treated.

But how many are there to be found, in whom the various talents required for such a work are so combined as to fulfil a task of such importance? or how many are there, who are so qualified, that will give up the time they might more interestingly spend in inquiring into some favourite subject, for the laborious task of compiling such a work;—a task in which such an extent of information is required, and which is only to be gained from an acquaintance with an almost countless number of books, which are difficult to be procured, and the study of which is extremely laborious? He also, who pretends to a work of this kind, should neither be possessed of a blinded confidence, nor a presumptuous incredulity; he should be armed on the one side by a philosophical scepticism, and on the other, by a penetrating scrutiny, that he may neither be led aside by the beauty, or the interest which pretended new observations might hold out, into that

train of theorising, to exclude which is partly the object of the work, nor presumptuously reject, unexamined, those observations which, if judiciously interpreted, might be of the most essential service. And lastly, he should think soundly, and reason philosophically; his style should be pointed, admitting nothing extraneous, but condensing the most useful information within the smallest possible compass.

The author has bestowed such a value on this work, as to secure to it the reputation of being the most complete and best executed system of Physiology which has yet appeared. But while the translator makes this assertion, he must not be considered as expressing his own conviction merely, but that of men much better qualified than himself to form a just opinion,—it is the opinion of some of the most enlightened and distinguished members of our profession. Were there ought of dogmatism in the opinions presented in the work, he should have had considerable doubt as to its intrinsic worth. But the author has nowhere betrayed the least prepossession; he seems to have followed the impressions which the phenomena of nature have conveyed to his mind. The translator can have no hesitation in expressing this as his candid opinion; as, from a knowledge of the author's other writings, he has found that he is one who scruples not to contradict his own assertions, when further experience and observation have convinced him of its necessity. He has not attempted to constrain nature to his opinions, but has founded his opinions on nature. This maxim has been closely and faithfully adhered to through the whole work. The reader may also expect to find nature clad in a garment which is prepared for her by the author;

but let him not fear to see her confined within a dress which he may have prepared for her before he knew what she was. The author has very judiciously introduced all the opinions connected with the theories of others, which he justly presumes will be useful and instructive to the reader ; but he is far from occupying his pages, or unnecessarily extending the limits of his work, by detailing the dreams and visionary speculations of those who vainly trust that their philosophical fictions will remain as immortal as the productions of a Homer. But it may be maintained, that the views brought forward in this work are not only the offspring of a truly philosophical and unprejudiced mind, but a striking proof of the ingenuity, penetration, and profound learning of its author.

The views which he takes of the various subjects of which he treats, are evidently the result of deep and scrupulous reflection ; nor can he any where be blamed of having too hastily drawn his conclusions, or of framing fanciful theories,—a propensity with which the Germans are very unjustly and illiberally impeached *. The work itself is both perspicuous and condensed ; every thing useful is mentioned, its value is tried by laconic and acute argumentation, extravagant hypotheses are refuted by the detail of

* These opinions, which have been too long current for the benefit of science, and which have been too much encouraged by the prejudice of some or the egotism of others, are now, I am led to believe, fast yielding to the more generous, more noble, and more enlightened principles of liberality. Dr. Duncan, Jun. of Edinburgh, whose extensive learning has long been known to the profession, has always been in the habit of making his pupils aware of the utility of an acquaintance with German literature ; the results of such exertions are too evident to require further comment.

facts, and from the common feature of the work, there is no admission to hypothesis, no favourite speculation can lie concealed in the garb of sophistry.

The great extent of reading which has been gone through, before the opinions offered on any particular subject have been decided, may be seen in every page ; and although it is not only commendable, but extremely desirable, that every student should consult the choicest works himself, it must also be allowed, that there are very few who have the opportunity or the means of doing so ; and therefore, to have collected into one focus, the rays of science which are scattered over a wilderness of various works, must appear to every one a very desirable object. These observations may not appear at first sight to be peculiarly referrible to this work ; but when it is understood how much the subject is extended, from the observations and discoveries of later naturalists, physiologists, and general anatomists, as well as the original views of the author himself, their application will be immediately admitted. The remarks appending to each paragraph of the text afford the most fertile source of information, and exhibit particularly the originality of the author. The comparative views instituted in these are numerous and well chosen, and the inferences deduced are striking and conclusive.

The author has also taken care to supply the deficiency of a great many elementary books, viz. to mention the various sources of information and instruction, a circumstance which will be highly appreciated by all those who wish to make the science of Physiology a particular study, or by those who may

wish to acquire a more extensive view of it, than can be gained solely from any elementary work. The introduction to every Book is followed by a small catalogue of the most select general works on the subject of it, and each Chapter is followed by a similar list of the most important monographs or particular chapters of general works, to which the student is referred for more extensive details.

The translator's comments, or those of any other person, could be of very little importance in a work of this kind. Condensation seems to be a paramount consideration with the author, by means of which he is enabled to introduce all necessary observations; and therefore, the usual additions to the translations of foreign works, *illustrations*, &c., are unnecessary and superfluous; the work is given to the public as an elementary treatise, and he may presume that the remarks of the author will be sufficiently illustrative of his own doctrine; if not, he can by no means be considered as fulfilling the duty he has undertaken, nor likely to be improved by the common-place observations and cases which are too frequently found among the notes and appendices of translators.

It has already been observed, that the author appears from every circumstance connected with its arrangement, to be remarkably free and unprejudiced. But unfortunately for the improvement of science in this country, the contrary has been too prevalent among the members of the medical profession; and where an individual, provoked by the humiliating condition in which we appear, has risen from among us to direct us in the more rational mode of improving our knowledge, by cherishing a free and unconstrained spirit of inquiry,

what has been his immediate success? he has been decried and condemned as a modern sceptic, and an infidel! This coarse declamation of unproven assertion, issuing as it does from those who have grown grey-haired under the yoke of established dogmatism, to whom, it is natural to imagine, it must be endeared by a life of implicit belief—must soon give way to the irresistible conviction of enlightened experience, and silenced by the prevalence of reason and of candour.

There are many physiological questions which appear to be for ever answered and set at rest, and yet it not unfrequently happens, that the explications which have been long current as satisfactory and conclusive, are at length rejected, and their place supplied by others which are quite of a contrary description. Every science is liable to this, and more particularly that of natural history, either from new discoveries in this field of inquiry, or from a more extensive view of the circumstances taken collectively, when even no new data present themselves.

It must appear evident in these days, when the natural history of Man has made some progress, and when it is understood what circumstances are likely to result from the inquiry, that there is a very intimate connection between it and Physiology. Thus in inquiring into the functions of the various organs of the human body, it is necessary, in the first place, to inquire, What the human body is, or what affinities or varieties it exhibits in comparison with the other objects of the creation? and 2dly, What distinctions they exhibit between themselves, from their situations under various climates, either moral or physical, and what powers they thence acquire of resisting the effects of certain influences? This, however, is the

only compendium of physiology which has appeared in this country, either original or translated, where this subject has been introduced.

It is very singular, as Blumenbach observes, that while natural history has been prosecuted with so much zeal in every cultivated nation—naturalists have never considered that we ourselves form a part, and certainly the most important part, of the science ; and that he, whose delineation ought to form the principal object of such inquiries, has been almost entirely neglected, and without thinking it at all an object of any importance to investigate the human race in a natural-historical sense, to delineate his character, and to describe the varieties exhibited by the various races, according to the peculiarities of the structure, and their respective powers, physical as well as mental.

HAROLD WALLERIUS, who was not a professed naturalist, but a mathematician in Upsala, was, it appears, the first, who, about the beginning of the last century, attempted to fill up the vacuum which had existed in natural history for such a surprising length of time ; his work * on this subject was considered to be a very excellent production for the time in which it appeared.

Notwithstanding the great importance of this subject, or the influence which it is now likely to exert on every department of literary pursuit, it has, until lately, been almost entirely neglected ; and it is to the extensive erudition and zealous pursuits of Blumen-

* *De varia hominum forma externa*, 1705, 4to. This was followed, in the year 1721, by the memorable writing of Jo. Alb. Fabricius, *Diss. critica, de hominibus orbis nostri incolis, specie et ortu inter se non differentibus*.—Vide Blumenbach's *Beiträge zur Naturgeschichte*, p. 55.

bach, that it owes the greatest part of the progress it has now made. And indeed it is almost exclusively to him that the merit of having procured to it an adequate share of attention in natural history is due. Since the first edition of this author's Inaugural Dissertation *, several other very eminent authors have successfully engaged themselves in the pursuit, the results of which shew us that there is more useful and interesting information to be derived from this source than was formerly thought possible.

But the circumstances observed in this field of inquiry, have, like every other, led to very opposite conclusions, in different authors—a spirit which invariably gives rise to more minute and accurate investigation. I would mention as the first and most extravagant of these hypotheses, that of considering Man and the Orang-utang as originally the same species of animal, or rather of considering Man as a sort of civilized Orang-utang. The second is, that the human inhabitants of the earth consist of more than one species, but that they belong collectively to one genus. The third and last, that mankind are all of the same species, merely exhibiting varieties among themselves, originating from certain operating causes, but that they are all widely different from any of the brute creation.

The latter of these opinions is that which has long been the most prevalent, and which has received its greatest supports and most successful illustrations from Prof. Blumenbach †, in his numerous anthropolo-

* This work has now reached the third edition:—*De Generis Humani Varietate Nativa*. Gott. 1795, 12mo.

† *Nullum inquam superesse dubitationi locum quin, omnes ac singulas, quotquot hactenus innotuerunt hominum varietates, ad unam eandem-*

gical works. The student who may wish a full and detailed account of these circumstances, with an ingenious exposition of their respective merits, I would refer to the excellent work of Mr. Lawrence*. And if an extensive collection of materials, a perspicuous arrangement of them, and an unprejudiced opinion, may be considered as of any value, this author ought to be carefully studied by every one who has taste enough for the inquiry, and sufficient patience to surmount its difficulties. The same doctrine was formerly taught by our author also, in his public lectures on natural history; but, as he informs us in one of his other writings†, doubts arose in his mind even during his lectures, and at length finished by this, that he taught a contrary opinion,—viz. that the human race, from the grounds accepted as valid in the other parts of natural history, must be considered as consisting of more than one species,—which seems to differ from the Mosaical account of the creation of man. As long as science and revelation, according to the degree of importance which the latter is considered to obtain in every thing that pertains to natural inquiry, are considered as necessarily unanimous, it must appear presumptuous in any author to publish such an opinion. Such an idea, however, does not appear likely ever to be productive of the

que *speciem* verisimillime referre liceat. *De Gen. Hum. Var. Nat.* p. 322.

The same opinion is contended for in all of his other writings in this department, as—*Decades cran. divers. gent. illust.*—*Beitr. zur Naturgesch.*—*Handb. der Naturgesch.*, &c.

* *Lectures on Physiology, Zoology, and the Natural History of Man*, London, 1823, 8vo, p. 102.

† *Beiträge zur Anthropologie*, &c., Berlin, 1812. *Ueber die Verbreitung organischer Körper*.

best consequences to religion, and is sure to act very injuriously on the promotion of science. To try every scientific observation by some occasional remarks interspersed through the Scriptures, intended perhaps to serve merely as a vehicle to more important truths, as of themselves, they are often extremely obscure, and sometimes very trifling as regards Christianity, is to annihilate completely the spirit of free and unprejudiced inquiry; for it is impossible that it can ever proceed towards perfection, while it is thus bound down by so many shackles. It is impossible that science and Mosaical history can ever be so reconciled in all their principles; and it is certain, that he who can succeed in proving that the object of Moses was to reveal science to mankind, will do more to confine than to increase that authority and restraint, which, in the abstract, Christianity is so happily calculated to enforce on the human mind *.

* The pious, the learned, and the eloquent Robert Hall, of Leicester, is constrained to admit, that philosophy and Christianity cannot coincide in all their principles. "When," says he, "under the pretext of simplifying it (Christianity), we attempt to force it into a closer alliance with the most approved systems of philosophy, we are sure to contract its bounds, and to diminish its force and authority over the consciences of men. It is dogmatic; not capable of being advanced with the progress of science, but fixed and immutable."

"We ought not (says Bacon) to attempt to draw down or submit the mysteries of God to our reason; but on the contrary, to raise and advance our reason to the divine truth. In this part of knowledge, touching divine philosophy, I am so far from noting any deficiency, that I rather note an excess; whereto I have digressed because of the extreme prejudice which both religion and philosophy have received from being *commixed together*, as that which undoubtedly will make an heretical religion and a fabulous philosophy."

By adducing these two high authorities as entertaining the idea of the impossibility of reconciling philosophy with *Christianity*, the translator is in hopes of exempting himself from the charge of presumption

It is not under such restraints, however, that science can ever prosper: it is the offspring of human reason and inquiry, and built up of such materials as are intelligible to the human mind. But revelation was intended by the Omnipotent Ruler of the universe, to convey to our mind those important truths and principles which constitute the basis of moral purity, and to hold out the means of acquiring the enjoyment of that intellectual paradise, which, without it, mankind had deemed to be the end of mortal existence.

But what connexion have the divine dogmata of revelation with the researches of the naturalist or physiologist, the accuracy of which are tried by the test of revealed writ, as if they had set out with the intention, simply of confirming by their labours the truth of them?

Had it been the object of revelation, either wholly or in part, to explain or give us accurate views of natural history or philosophy in general, it would scarcely have been necessary to pursue the inquiry further, but to rest satisfied with the information which it contains. When the opinions of astronomers happen to stand in direct contradiction to the representations of the Jews in the Old Testament, this causes no surprise; and just as little when the geognosy of our times, established by the laborious exertions of individuals, is completely different from that of Moses, who had seen but a small spot of the earth, and who was deprived of all the assistance

in offering the above opinions with regard to the necessity for the naturalist to adhere so closely to the historical account of Moses, whose inspiration has, in fact, been altogether denied by some very learned divines.

with which we are now provided. When it is admitted, therefore, that Moses is no authority either in astronomy or geognosy, and when revelation, as will be readily admitted, appears to have had not the slightest relation to science, is it not extremely illiberal, unjust, and absurd in the extreme, to condemn a doctrine as false, merely because it shews (according to scientific principles) that Moses is not the first authority in anthropology?

If we even follow the Jewish mythology itself, on which the whole theory is erected, we perceive in it many circumstances which tend to shew us that the whole history relates peculiarly to the Jewish nation. Thus from the history of Abraham and his descendants, we find that it relates only to the children of God, as they have been called, in contradistinction to the children of men, meaning the inhabitants of the neighbouring countries, who were much more numerous than the Jews. We find also that of the two first sons of Adam and Eve, the one is murdered by his brother, so that we have an evidence here, that the same disasters which happen in these days, were in action even at the accepted time of man's creation; and a short time afterwards we find that the whole human race were reduced to a single family by the flood.

But let us leave this mythology out of the question, which is singularly enough accepted as the basis of a scientific theory, which, however, can never be the object of a revelation.

It is experience alone on which we can trust for the promotion of science, and if this can be considered as availing us any thing in the department of anthropology, we may assert, without the fear of con-

tradiction, that there is not the slightest shade of an authority for concluding that two persons have, in the course of a few thousand years, multiplied so exceedingly as to amount to the remarkable number of many hundred millions *.

From the testimony of history, in fact, we are fully authorized to conclude, that under particular modifications, the bulk of the population of the earth has been always nearly about the same as at present; and there is just as little authority for believing in a general increase in population, as in their common descent. After a few thousand years, mankind will perhaps have improved as little in number as in morality. But were the case actually otherwise, viz. that in spite of all opposing causes, pestilence, wars, revolutions, &c., of the early existence of which we have numerous authorities, the population of the earth still continued to increase, we must then admit that new migrations of the people must be taking place from time to time, and these at certain periods; but the consequence of such increase would be, that the population would become too great for the earth. For such an opinion, however, we have no authority. It is certain, that the population of individual countries increases rapidly for a certain time, but the cause of such an increase must be looked for from another source than the fecundity of its proper inhabitants. A country which is fertile, and favourably situated for commerce, soon attracts the stranger from the remotest regions, by the advantages which it holds out. But this prosperity is only for a time; it has its day of improve-

* Vide 51. *Rem.*

ment and strength, it attracts the envy of its neighbours, by whose machinations, intestine misfortunes, &c., it gradually falls into decay, and at length is lost in the silence of its original obscurity.

We may now look to the manner in which the earth has been so singularly distributed to the various nations. If we imagine, that when one nation has increased, and become formidable to its neighbours, it has driven them hence, where are these, who must, by the same means have proportionably multiplied, to seek refuge? We are here fallen into a labyrinth from which it is difficult to extricate ourselves.

Man, provided as he is, with such a pliable constitution of body, is able to undergo very remarkable changes of abode, at least when we take into consideration the reason with which he is provided, which affords him the means of protecting himself against innumerable evils. These changes, however, are confined within certain bounds. Thus, if a colony of Negroes were transported to Greenland, they would not long exist; nor would the existence of the Laplander be longer, if he were transported to the more southern regions of the Negro.

This objection is answered by saying, that the distribution of the inhabitants of the earth has taken place but slowly; but to produce a distribution of mankind, as they are at present, would perhaps require many millions of years; and thus the answer embraces another still greater improbability.

If mankind had extended themselves so slowly over the earth, it must naturally appear, that the peculiarities of neighbouring people would not be so

considerable, and that there would exist a natural transition from one race of people to another, according to their situations, which is also contradicted by numerous examples.

In the time of Alexander the Great, the Jews were already distributed through Persia, and many other parts of Asia; they had settled in Egypt at a very early period, and their first entrance into Abyssinia is likewise very remote. In the time of Julius Cæsar, they were nearly as firmly rooted at Rome, as they are in Poland and many other countries of Europe at the present day. But as their civil relations to the native inhabitants are always very rare, their appearance has in like manner remained unaltered. The colour of the skin, however, exhibits a variety, as at one place it is clearer, at another darker, but their faces and skulls always retain their original national peculiar character.

The colonies of Europeans which are now existing, and have existed for some time, in various parts of Asia, Africa, and America, are of the same exact construction and expression of countenance as their original stock, the Europeans; and the Negroes exhibit the same unchangeableness of form to whatever country they be transported; they still have their original appearance, and perhaps would still retain it, were they to remain for the greatest possible number of years.

Leaving out of the question the impossibility of explaining, according to this hypothesis, the immense difference between the construction of the European and Mongol, between the European and the Negro, and between the European and the Papu,—if it be correct, that all the varieties of man have degenerated

from the parent stock, it must follow, that this must have a commencement, and with respect to the Jews, this must have already been finished, if we consider that the Negroes have by degenerating become Negroes. It must therefore strike every one as evident, admitting that the Negroes have degenerated from the parent stock, that it must have been completed at a very early period, for they are mentioned as such in our earliest histories; and, on the other hand, we are informed that the world has not been a very great number of years in existence, at least under its present form. These circumstances present to our minds evident contradictions*.

From such observations, therefore, it appears that we have no reason to doubt the possibility at least, of the plurality of the human species, provided it be sufficiently authorized by a preponderance of probability and argument. With regard to the unlikelihood, and, according to zoological principles, the impossibility, of collecting all the different species of living animals together in the ark, I shall make no mention in this place, as it does not bear so directly on the point in question. These calculations, however, ought never to be taken into consideration as respects our Christian faith. When they happen to be opposed to it, they ought to have no prejudicial influence on our minds; when a coincidence appears between them, we ought to be affected in no other way than delighted at the circumstance.

With regard to the merits of the translation, it would be improper to say any thing in this place. The

* I refer the reader for further arguments in favour of this opinion, to Rudolphi's *Beiträge zur Naturgesch.* p. 145. Ueber die Verbreitung der Menschen.

translator thought it his duty in most cases to adhere as closely as possible to the precise terms of the author. Simplicity of expression, and a faithful adherence to the original, have been his principal objects, persuaded that plain language, and a faithful translation, are the chief requirements in the task he has undertaken, with the attainment of which he will be fully satisfied. The style, however, is often abrupt, which is occasioned by the aphoristical style pursued by the author, in order to embrace as much information as possible within a limited space. In translating from the German, a work in which there is so much of a local nature, and where the terminology is altogether different from our own, or that pursued in medicine by the other European authors,—that even the most enlightened physiologists might be placed under considerable difficulties, the translator cannot but feel diffident lest a few inaccuracies may have crept into this edition, notwithstanding the great care he has taken to avoid it. Whatever inaccuracies, however, may be found, he trusts that there are none of such importance as in any way to alter the sense of a passage, or even the definition of any term. And therefore, as they are not likely to mislead even the most inexperienced inquirer, they may easily be corrected by those whose experience is more extensive, and whose learning is more profound.

BERWICK, }
September, 1825. }

AUTHOR'S PREFACE.

To compile a Manual of Physiology appears to me to be one of the most difficult and unthankful offices, and it may easily be conceived how much more interest there must be in executing some other literary production, in which we can, with more detail, treat of new subjects according to our own particular choice. In a compendium it is necessary to mention the most familiar circumstances, as its object is to give a certain view of the whole ; and on the other hand, physiology is a science so very extensive, that it becomes a matter of extreme difficulty, on account of the limited space afforded in such a work, to give a sufficient view of all the circumstances comprehended under its dominion ; and lastly, let us choose whatever arrangement we may think proper, we will never find ourselves altogether satisfied with it.

As often, therefore, as I undertook the task of writing a Manual of Physiology, was I always more inclined to engage myself in some other literary employment, until I had at length overcome my dislike to it, as I considered myself to be thus far indebted to my pupils.

I have never written a volume on Physiology or any other science for my lectures, in order that I might not confine myself to any particular arrangement ; but in preparing for the individual chapters, I drew up a plan, which I tried and altered every succeeding course, according as I found it answer

my purpose. I readily admit, that lectures delivered according to a certain plan or volume are more uniform, and perhaps even more complete ; but the lecturer at least gains by an extemporaneous delivery, as he is then not confined, and consequently can make new alterations, according to any new discovery, and can at one time try one arrangement, and a different one at another ; but particularly as the lecturing itself teaches him best how any particular subject ought to be treated. Things properly arranged cause no difficulty during the lecture, but we soon perceive otherwise what deficiencies exist. It has sometimes happened during my lectures that I have been very dissatisfied with myself ; it has also happened that I have closed the lecture with quite a different view of the subject from that with which I commenced it, for I myself heard the weak arguments in its favour, and the powerful ones against it. These are no inconsiderable advantages.

Extemporaneous lecturing is also advantageous to the students, as the lecturer is soon aware whether or not they understand him, and if not, he can easily explain the circumstance to them a second time in another way.

Some authors disapprove of polemical lecturing, but I consider it as indispensable, as the student is thereby led much further into the subject. It may happen that the lecturer often unobservedly, and sometimes even unconsciously, withholds his opinions on doubtful circumstances ; in general they decide in favour of a certain theory on the grounds brought forward in its favour. A purely dogmatical plan of lecturing appears to me to be the greatest presumption.

I consider it as of the greatest importance to collect together as much matter of fact as possible ; for many of our Manuals, which are sometimes written with considerable spirit, have the merited objection attached to them, viz. that they contain far too much reasoning, and far too little matter of fact. The former is of very little consequence either to the hearer or the reader, when they are destitute of the latter ; and when it is objected to Physiology that it does not contribute sufficiently to Pathology, &c., it arises chiefly from this misconception. If all physiological authors were asked which they considered as the best system, no person could have any

objection to it if each mentioned his own; but if they were asked further, which they considered as the second, I am certain they would all, without exception, mention *Haller's Physiology*. But that which all authors consider as the second, must undoubtedly be the first; not on account of his hypotheses, nor yet on account of the arrangement of the matter, but on account of the great abundance of facts. His work, therefore, will remain for ever invaluable, for we find every where in it, that which is merely occasionally found in others,—the most profound information.

Haller could very well publish his introductory work on Physiology without the literature, on account of having given it in such abundance in his larger work, which might thence be considered as commentaries. Later physiologists, on the contrary, who have neglected this, have acted very improperly, for they have in this manner placed themselves in the greatest danger of being neglected, and at the same time have deprived their hearers of the most important means of acquiring their future accomplishment. How few of them are there who will afterwards have the opportunity of acquiring the necessary literary information: but numbers of them on this very account remain completely crippled and inactive, or perhaps after a long time find out something without knowing that it had been already long known. To this also may be attributed the evil practice of later years, of copying the quotations of one author from another, without mentioning that they have done so, so that they are copied to no purpose, and when they have gone on in this manner they must at length feel themselves mortified. The works which I have quoted in this Manual without having had them before me, are marked thus †.

I expect that the arrangement which I have followed will meet with considerable censure, which will no doubt be very just in many respects: I have nothing more to say in its behalf, than that it appeared to me the most convenient which I have as yet tried. Some circumstances will also perhaps justify themselves when the second volume appears.

The form of this compendium is the same as that of our earlier manuals, viz. of an *Erleben*, or that of a *Weigel*, my

distinguished teacher, to whom I can never be sufficiently grateful for the kindness he has shewn me. It is in this form alone that we are able to compress so much information within a small compass, as in this way we have an opportunity of easily introducing a great many circumstances which we would otherwise not know how to leave unmentioned.

The greater or less extensive detail of the different subjects of this work I consider as completely left to myself. Wherever I have treated of any thing more fully than what might have been absolutely necessary, I consider it as of no moment. This is perhaps the only circumstance in a work of the kind which can give the author any pleasure, when, for instance, he can go more deeply into a subject which is more agreeable to his taste. I trust also that I may not on this account have neglected any thing of consequence, as our profession is perhaps not completely without its advantages from this source; as for example, in general anatomy, on the nerves, the membranes; and afterwards on the doctrine of the blood, of heat, of the electric organs, &c.

I have always been at the trouble to mention the necessary critique, and have, as much as I am able, fulfilled the duty of truth and impartiality. I have never, to my knowledge, made any misrepresentation, nor intentionally suppressed any circumstance which has the least tendency to subvert my own views. Attached from my early youth to the study of nature, I have had no other aim but science: I have seen both myself and others err, but as I have always acknowledged my error as soon as I had detected it, nothing shall deter me from declaring as true or false that which I consider to be true or false in others.

It is in this manner that in magnetism, i. e. in all the wonders which are therein sought for and believed, in the perception of the metal, in the description of the interior of the body, in the capability given by the magnetiser of hearing and seeing by other parts than the organs of sense, &c. I have witnessed nothing more than error and delusion, and Klaproth, Erman, Horn, Knape, v. Koenen, Weitsch, and many others of my friends and colleagues, have never observed in it any thing more than myself. I must often return to this

subject, but considered it necessary to make a general mention of it in this place. I would have been altogether silent respecting it, but it is not with magnetism as with many other theories, which from their simplicity are unlikely to exert any pernicious influence on the advancement of science. But as it makes progress in the world, our way is beset by every evil, for it kills science in the bud, and advances forward hand in hand with mystery and falsehood.

Alii putaverunt, sciri posse omnia, hi sapientes utique non fuerunt. Alii nihil, ne hi quidem sapientes fuerunt. Illi, quia plus homini dederunt, hi quia minus. Utrisque in utramque partem modus defuit. Ubi ergo sapientia est? Ut neque te omnia scire putes, quod Dei est, neque omnia nescire, quod pecudis. Est enim aliquid medium, quod sit hominis, id est scientia cum ignoratione conjuncta atque temperata.—LACTANT. De falsa sapientia. Opp. ed. Bipont. T. 1. p. 170.

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INTRODUCTION.

1.

PHYSIOLOGY is the Doctrine of the organisation of the human body.

Rem. 1. The word physiology properly signifies the doctrine of nature; of the nature of mankind; we always consider physiology, pathology, therapeutics, &c. as applied to mankind in particular, unless the contrary be signified.

Rem. 2. This word has been applied with various significations,—it has been used, for example, to signify the use of the various parts; their actions, life, &c. There are likewise other terms which are considered as synonymous with it, as *Zoonomy*.

2.

An organised substance without life is a thing which cannot be conceived, because, as soon as the one begins to exist, the other likewise exists in the same degree, and both cease to exist at the same moment.

Rem. It is therefore superfluous to speak of a living organised body. Neither can we say that life is the origin of organisation, or that the former only ceases to exist when the latter is destroyed. The dead body of a human being, or of an animal preserved in spirits, has no organisation, but is merely a certain sum of its parts. Organisation may be rapidly or gradually destroyed, and life is more quickly or slowly destroyed accordingly.

Organisation is not only the source of bodily, but also of mental action.

Rem. The latter, however, is only to be considered here in a general sense, and in so far as it is necessary to a proper understanding of the whole; it belongs to psychology to treat this subject in as full and detailed a manner as it will admit of; to treat it here in as perfect a manner as the physical part, would by far exceed the limits of a course of lectures.

4.

The system, as a whole, is so intimately connected in all its parts, which harmonize so exactly, that the proper function of each individual organ is necessary to that of the others. We are therefore unable to form an accurate conception of any individual part, until we have gained a proper knowledge of the whole.

5.

Organisation must at first be studied generally, and afterwards individually. The individual organs of the body can only be represented in a forced, and, in a great measure, arbitrary arrangement, as it is not after each other, but with and through each other that they exist and act.

Rem. General physiology is altogether the product of late enquiry, particularly that of the German authors. The physiology of these authors formerly consisted merely of the doctrine of the functions of individual parts, by whom the want of general physiology must have been greatly felt.

6.

Physiology, therefore, consists of a general and a special part, each of which is again subdivided under various heads.

<i>General Physiology.</i>	$\left\{ \begin{array}{l} a \text{ Anthropology} \\ b \text{ Anthropotomy} \\ c \text{ Anthropochemistry} \\ d \text{ Zoonomy.} \end{array} \right.$	<i>Special Physiology.</i>	$\left\{ \begin{array}{l} a \text{ Sensation} \\ b \text{ Motion} \\ c \text{ Nutrition} \\ d \text{ Generation.} \end{array} \right.$
----------------------------	--	----------------------------	--

3

Rem. 1. The doctrine of generation is comprehended under general physiology, in so far as the origin of the germ is concerned ; but those circumstances which depend on the functions of individual parts, will be more conveniently treated of in the special part. The developement of the fœtus is described in the latter, and with this subject that part of the work closes, so that we return again to the general part.

Rem. 2. Special physiology will commence most naturally with the consideration of Sensibility and Irritability, as these subjects are more closely connected with Zoonomy.

Rem. 3. Physiology was formerly divided into sections on the *vital*, the *animal*, the *natural*, and the *generative* functions.

7.

Physiology can only be prosecuted and perfected in the same way as the other branches of natural philosophy. Here also it is from careful and repeated experiments and observations alone that we derive facts, which the mind arranges, and from which we draw general conclusions.

Rem. When a physiological fact appears to have been merely founded on speculation, it may easily be conceived what a mass of experiments must have been instituted before such a fact could be ascertained. When facts become properly established, a true theory follows as their natural consequence ; and until this shall be the case, we must content ourselves with hypotheses, which serve to keep us in action, and naturally lead us to new observations and experiments.

8.

The sciences which contribute most to our assistance in prosecuting the study of Physiology are, Natural History and Philosophy, Chemistry, Anatomy, and Pathology.

9.

While *Natural History* describes and arranges natural bodies with one another, according to the affinities they exhibit in common, it also teaches us the rank of Man in the creation, and the relations which he bears to other creatures. Without a knowledge of it we would never be able to form an accurate idea of him ; we would either exalt the lower animals to a par with Man, or place him on a level with them.

Rem. Anthropology, in the full sense of the word as received by natural historians, implies, the fruit of the study of Natural History; for without it we could have no comparative anatomy. When we look back to the days of Haller, and observe the great progress which has since been made in all those parts of natural history which are interesting to us, we may be allowed to expect daily new information on the subject.

10.

By *Natural Philosophy* we are taught to know the powers of nature and its laws, and in this we find one of the richest sources of information, as well in respect to Zoonomy in general, as for gaining a knowledge of most, if not of all individual organs.

Rem. In former times, when philosophy consisted solely of mathematics, it was even then, of considerable advantage to us by the doctrine of the lever, the reflexion and refraction of light, of sound, &c. but then it obtained an absolute sway, by means of which life was left quite in the back-ground, as for example, in muscular motion, or it partially excluded chemistry, as in the doctrine of respiration.

11.

Chemistry is a science which is daily exciting us to encourage the hope that we will at length find a greater assistance from it in the study of physiology than we can at present boast of. It is with considerable dread that it is at all employed.

Rem. Its present slight connexion with natural philosophy is of particular importance to us, and there is no doubt that the assistance of chemistry is required for the explanation of innumerable appearances which present in the system, but the more proximate connexions between these, lie for the most part concealed from us. As soon as we constitute chemistry the ruler of physiology, we at the same time class our system with the bodies of the inorganic kingdom, as it is actually from these bodies alone that chemistry has its being.

12.

The science of *Anatomy*, and *Comparative Anatomy* in particular, constitutes the most solid basis of special physiology,

and according to the degree of progress they make, do we become the more exactly acquainted with the functions of parts.

Rem. 1. When physiology was considered merely as a reasoning anatomy, it is evident there could have been no general physiology. But it is perhaps a fortunate circumstance that it did commence in this way, and it is to be hoped that anatomy, as an assistant-science to physiology, will never be neglected. As a reason for this, let us compare our knowledge of the functions of those parts with whose structure we are well acquainted, as for example, of the eye, the heart, the ear, &c. with many others of whose organisation we know little or nothing, as of the brain.

Rem. 2. Comparative Anatomy, as applicable to the study of physiology, is even of greater importance to us than the anatomy of the human body, as far as the signification of the parts of an organ is concerned, as for example, of the organs of the senses; and how scanty would have been our knowledge of the circulation of the blood, of digestion, production, reproduction, &c. if we had been deprived of the many advantages afforded by this guiding star.

13.

Pathology, but more particularly *Pathological Anatomy*, is likewise one of the most fertile sources of physiological truths, and it would be a great deal more so if we possessed a system of comparative pathology worthy of the name.

Rem. 1. Pathology coincides so much in its general principles with physiology, that to combine them together in one work would be an undertaking worthy of commendation, as has been done by Pfaff, vide 16. But in lectures it is necessary to teach them separately, lest too little be said on each. Consult on the union of Physiology and Pathology my *Anat. Physiol. Abhandlungen*, S. 225.

Rem. 2. By the study of morbid anatomy we frequently acquire very bright views, as well in respect to the subject of life in general, as to the life of individual parts; and in like manner, by examining the morbid condition of a part, it is by means of pathology that we first acquire an accurate knowledge of its structure.

Rem. 3. It is of infinite advantage to physiology, to be enabled to place animals in various diseased conditions, and by means of dissections carefully to follow these and all the re-actions of the system and repro-

ductive power step by step. For this purpose vivisections are generally not required, at least, not of so horrible a description as those mentioned in late physiological authors, which cannot be read but with disgust.

14.

The great influence which physiology exerts on the other sciences, is very conspicuous. Without it, how deficient would have been psychology, and medicine how spiritless! It may justly be considered as the flowers of all natural philosophy.

15.

The physiological literature of earlier times may be found in the greatest abundance in the immortal writings of the great Haller.

Bibliotheca Anatomica, T. II. Tiguri, 1774—1777, 4to.

Elementa Physiologiæ corporis humani, T. I—VIII. Lausann, 1757.—Bern, 1766, 4to. The additions from later editions, which contain only half of the above work, are printed alone: *De partium corporis humani præcipuarum fabrica et functionibus*, T. 1—8, Bern, 1777. *Auctarium ad Alb. Halleri Elementa Physiologiæ*, Fasc. IV. Lips. et Francf. 1780, 4to.

Primæ Lineæ Physiologiæ, Ed. Hnr. Aug. Wrisberg. Gott. 1780, 8vo.

16.

Many introductory books on physiology have appeared in Germany since the time of Haller, but of various worth.

J. Fr. Blumenbach, *Institutiones Physiologiæ*, Gott. 1787, 8vo. Ed. 3. ib. 1810, 8vo..

J. Dan. Metzger, *Physiologie in Aphorismen*, Königsb. 1789, 8vo.

Fr. Hildebrandt, *Lehrbuch der Physiologie*, Erlang. 1796, 8vo. Vierte Ausg. ib. 1809, 8vo.

Ge. Prochaska, *Lehrsätze aus der Physiologie*, Wien,

1797, 8vo. Dritte Ausg. 1810, 8vo.—Physiologie oder Lehre von der Natur des Menschen. ib. 1820, 8vo.

C. Chr. Erh. Schmidt, Physiologie philosophisch bearbeitet. 3 Bde. Jen. 1798—1801, 8vo.

Fr. Ludw. Kreysig, Neue Darstellung der Physiolog. und patholog. Grundlehren, Lpz. 1798, 1800, 2 Thle. 8vo.

J. Hnr. Ferd. Autenrieth, Handbuch der empirischen menschl. Physiologie, Tübing, 1801, 2. 3 Thle. 8vo.

C. H. Pfaff, Grundriss einer allgemeinen Physiologie und Pathologie des menschl. Körpers. 1. B. Kopenh. 1801, 8vo.

Theod. Ge. Aug. Roose, Grundriss physiologisch anthropologischer Vorlesungen. Braunsch. 1801, 8vo.

Gottfr. Reinh. Treviranus Biologie oder Philosophie der lebenden Natur. Gött. 1802—18. 5 Bde. 8vo, & cont.

J. Jos. Dömling, Lehrbuch der Physiologie des Menschen, 1. B. Gött. 1802, 8vo, (2. B. 1803. †.)

J. Görres, Aphorismen über die Organonomie. Kobl. 1803, 8vo.—Exposition der Physiologie. Organologie, ib. 1805. 8vo.

Aug. Winkelmann, Einleitung in die dynamische Physiologie. Gott. 1803, 8vo.

Cph. Bernoulli, Versuch einer physischen Anthropologie, oder Darstellung des physischen Menschen. Halle, 1804, 2 Bde. 8vo.

Aloys Rdph. Vetter, Erklärungen der Physiologie. 2te Aufl. Wien, 1805, 2 Bde. 8vo.

J. C. Hnr. Meyer, Grundriss der Physiologie des menschlichen Körpers. Berl. 1805, 8vo.

Ign. Döllinger, Grundriss der Naturlehre des menschl. Organismus. Bamb. u. Wirzb. 1805, 8vo.

Ph. Fr. Walter, Physiologie des Menschen. Landshut, 1807, 2 Bde. 8vo.

Aug. Ed. Kessler, Grundzüge zu einem System der Physiologie des Organismus. Jen. u. Lpz. 1807, 8vo.

J. C. A. Heinroth, Grundzüge der Naturlehre des Menschl. Organismus, Lpz. 1807, 8vo.

Ernst Bartel's, systematischer Entwurf einer allgemeinen Biologie. Frankf. a. M. 1808, 8vo.—Physiologie der menschl. Lebensthätigkeit. Freyberg, 1809, 8vo.

Curt. Sprengel, Institutiones physiologicae, Amst. 1809, 10. Voll. II. 8vo.

Fr. Ludw. Augustin, Lehrbuch der Physiologie des Menschen, 1. B. Berl. 1809, 8vo.

K. Fr. Burdach, Die Physiologie, Lpz. 1810, 8vo.

J. Bernh. Wilbrand, Physiologie des Menschen, 1815, 8vo.

K. Ge. Neumann, Von der Natur des Menschen. Berlin, 1815 and 18. 2 Thle. 8vo.

Mich. a Lenhossek, Physiologia medicinalis, Pest. 1816—18, Voll. V. 8vo.

Adph. Fr. Hempel, Einleitung in die Physiologie des Menschlichen Körpers. Gött. 1818, 8vo.

17.

The number of elementary physiological works published in other countries is not so great as in Germany; their merits, however, are equally as various.

L. M. A. Caldani, Institutiones, physiologicae. Ed. 2. Patav. 1778. (Ed. Lpz. 1785, 8vo. †.)

Mich. Attumonelli, Elementi di Fisiologia medica ossia la Fisica del corpo umano. Nap. 1789. P. 1—5, 8vo.

Giov. Presciani, Discorsi elementari di Anatomia e Fisiologia, P. 1. Milano, 1794, 8vo.

Azzoguidi, Compendio de' discorsi che si tengono della cattedra di Fisiologia e di Notomia comparata. Bologna, 1808, 8vo.

Stef. Gallini, Nuovi Elementi della Fisica del corpo umano, Voll. II. Padova, 1808, 8vo.

Gius. Jacopi, Elementi di Fisiologia e Notomia comparativa. Nap. 1810, Voll. III. 8vo.

Nic. Jadelot, Physica Hominis sani, seu explicatio functionum corporis humani. Nanc. 1778, 8vo.

F. R. Buisson, De la division la plus naturelle des phéno-

mènes physiologiques considérés chez l'homme. Paris, 1802, Svo.

P. J. Barthez, Nouveaux élémens de la science de l'homme. Ed. 2. Paris, 1806, Voll. II. Svo.

Anthelme Richerand, Nouveaux élémens de Physiologie, Ed. 4. Paris, 1807. Voll. II. Svo. (Ed. 8. ib. 1820. Voll. II. Svo.)

Charles Louis Dumas, Principes de Physiologie. Ed. 2. Paris, 1806. Voll. IV. Svo.

J. C. Foderé, Essai de Physiologie positive appliquée spécialement à la Médecine pratique. Paris, 1806. Voll. III. Svo.

F. Magendie, Précis élémentaire de Physiologie. Paris, 1816, 17. T. II. Svo.

Adph. Ypëy, Principia Anatomico-Physiologica. L. B. 1817, Svo.

W. Cullen, Institutions of Medicine, P. I. Physiology. Edinb. 1777, Svo.

Jacob. Gregory, Conspectus Medicinæ Theoreticæ, P. I. Physiologiam et Pathologiam cont. Edinb. 1780, 8vo. Ed. III. ib. 1789, Svo †.

Erasmus Darwin, Zoonomia, or the Laws of Organic Life, Voll. IV. 8vo, Lond. 1801.

John Gordon, Outlines of Lectures on Physiology, Edin. 1817, 8vo.

W. Lawrence, Lectures on Physiology, Zoology and the Natural History of Man, Lond. 1819. 8vo.

18.

Mixed Writings are of particular use in the study of physiology, whose contents consist of anatomical, physiological and pathological subjects.

A. Collections.

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PART FIRST.

OF

GENERAL PHYSIOLOGY.

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BOOK I.

OF ANTHROPOLOGY.

19.

ANTHROPOLOGY, or the natural history of man, compares man with the other creatures of the earth for the purpose of marking those circumstances which are peculiar to him, and by this means, of pointing out his rank in the system of nature ; and in the second place, it compares the different tribes of people in the earth with each other, in order to determine the affinities as well as the varieties they exhibit.

Rem. The term Anthropology is here applied with the same relation to that part of Zoology of which we are treating, as Ornithology, Ichthyology, &c. are used by natural historians who treat of these branches. By some authors, however, it is used to signify Psychology, and inasmuch as the mind of man is his noblest part, it cannot be blamed. Others again, as Loder, universally represent medical disciplines under the title of Anthropology.

It is from having required such great strides, and the assistance of so many other sciences, that the natural history of man has been thus late in arriving at any degree of eminence.

J. F. Blumenbach, *De generis humani varietate nativa*, Gött. 1776, 8vo, Ed. 2. 1781. Ed. 3. 1795, 8vo.

J. Gottfr. Herder, *Ideen zur Philosophie der Geschichte der Menschheit*, Riga and Lpz. 1785—92, 4 Voll. 8vo.

Wilh. Josephi, *Grundriss der Naturgesch. des Menschen*. Hamb. 1790, 8vo.

Chr. Fr. Ludwig, *Grundriss der Naturgeschichte der Menschenspecies*, Lpz. 1796, 8vo.

J. J. Virey, *Histoire naturelle du genre humain*. Paris an IX. 2 T. 8vo. Nouv. Ed. ib. 1824, 3 T. 8vo.—*Recherches sur la nature et les facultés de l'homme*, ib. 1817, 8vo.

C. Grosse, *Magazin für die Naturgeschichte des Menschen*. Zittau and Lpz. 1788—91, 3 Voll. 8vo.

CHAPTER I.

DISTINCTIONS BETWEEN MAN AND THE LOWER ANIMALS.

21.

Man belongs to the tribe of *Mammalia*, and ranks next to the quadrumanous (four-handed), or monkey tribe, as well on account of his external appearance, as the construction of the different parts of his body.

Simia quam similis turpissima bestia nobis.

22.

The resemblance which the *simiæ* bear to the human race, is a circumstance which has been greatly exaggerated, which

has partly arisen from too much faith having been put in the fabulous narratives of travellers, and particularly, from the more resembling Pongo, when young, having been considered as a distinct animal under the name of Orang-Utang (*Simia Satyrus*).

Rem. The having shewn the Orang-Utang to be merely a young Pongo, is one of the most interesting discoveries of later years, as by means of this we find that the so highly boasted anthropomorphism merely exhibits that period of transition, when the lower animals appear more closely to resemble man in the form of their individual parts. Tilesius was the first who formed this conjecture, and Cuvier has since declared himself to be decided to the same effect. Lawrence (*Physiol.* p. 113.) brings forward very good grounds for entertaining a similar opinion. I have a young mandril in the anatomical Museum, which approaches so near to man in appearance, that scarcely any person would imagine him to be a baboon. What Abel says on the contrary is of no importance.

Homo troglodytes, nocturnus, Linn. *Syst. Nat.* ed. xii.—Pet. Camper, *De l'Orang-Utang*.—W. Gottl. Tilesius, *Naturhist. Früchte der ersten russischen Erdumseglung*. Petersb. 1813, 4to, s. 109—130. with excellent plates of the animal from the Atlas of Krusenstern. A beautiful engraving, with a description, may be found in Clarke Abel's *Narrative of a Journey in the interior of China*. Lond. 1818, 8vo, p. 320—330, 365—373. For the sake of brevity I must pass over the older writings, as well as the later ones of Vosmaer and Oskamp.

For figures of the skull of the Orang-Utang see, Camper, l. c. Tab. II.—Blumenbach, *Abbild. naturhist. Gegenstände*, Tab. 52.—Cuvier, *Tableau élément. d. l'hist. nat.* Tab. 3.—Crull, (*vide* 30.) J. B. Audubert has given a plate exhibiting a front view of the skull and whole skeleton of the Pongo, in his *Histoire naturelle des singes et des Makis*. Paris, An. 8. fol. p. 21. *Tabb. anat.* II. fig. 5. 6.

23.

Later authors have considered man as a descendant of the monkey tribe, that he has detached himself from his original stock, and in process of time become ennobled; but such

a conclusion can only be drawn by setting aside all natural-historical observations.

Rem. It is impossible that one animal can be so acted upon by the influence of external circumstances, as to take on the appearance of any other animal; from the copulation of simiæ of different species an intermediate species of simia might arise, but that man could arise from this source is a thing impossible. Man was always the same creature, and he will ever remain so.

Such objectionable hypotheses may, however, be found in the work of P. Moscati, *Della corporee differenze essenziali che passano fra la struttura de' Bruti e la umana*. Milano, 1770, 8vo.—Frz. J. Schelver, *über den ursprünglichen Stamm des Menschengeschlechts*, in *Wiedemann's Zoolog. Archiv*. III. 1. S. 167.—J. E. Doornik, *wijsgeerig-natuurkundig Onderzoek aangaande den oorspronglijken Mensch*. Amst. 1808, 8vo.

There is a well founded contradiction of this in Blumenbach and Herder, and particularly in G. Bakker, *Natur-en geschiedkundig Onderzoek aangaande den oorspronglijken stam van het menschlijk Geslacht*. Harlem, 1810, 8vo.

24.

In instituting a comparison between man and the other creatures which inhabit the earth, it is necessary that we should represent him in a state of perfect developement, and not morally or physically deformed, as are nearly all those cases of children found in the wild state.

Rem. 1. Wild Peter of Hameln was evidently an idiot, as has been shewn by Blumenbach, *Beiträge*, II. S. 13. The boy in whom M. Itard was so paternally interested was also foolish, and always remained so: *De l'éducation d'un homme sauvage, ou des premières développemens physiques et moraux du jeune Sauvage de l'Aveyron*. Paris, 1801, 8vo. and *Rapport sur les nouveaux développemens et l'état actuel du sauvage de l'Aveyron*. ib. 1807, 8vo. His skull, according to Larrey, (*Mémoires de Chirurgie militaire et Campagnes*. T. IV. Paris,

1801, 8vo, p. 18.) was so greatly deformed that he compares it to the skull of the Lithuanian boy, and that of the Orang-Utang.

The *Histoire d'une jeune fille sauvage*. Paris, 1755, 8vo. 1761, 8vo, p. 8. is very unsatisfactory, but yet this young woman (afterwards Mlle. le Blanc and Nounne) appears to have possessed more understanding. The negro boy, who was thrown by shipwreck on the island of Barra, was evidently deformed, but notwithstanding this, he still retained the recollection of his former situation, of the life he had led, and the particular fate of a savage boy during twelve years; he was at length taken at Barra, and educated by two celebrated physicians. Erkf. and Lpz. 1759, 8vo.

The boys who were found in Lithuania with a bear, never exhibited any mental developement when in human society, vide Gabr. Rzaczynski, *Hist. Nat. Polonie*, Sandomir, 1721, 4to, p. 354. and Bern. Conner, *Evangelium Medici*. Jenæ. 1724, 8vo, p. 133.—Larrey (*Mémoires, &c.*) saw the skull of one of them at Wilna, which resembled that of an idiot.—Gall likewise (*Anatomie et Physiologie du système nerveux en général et du cerveau en particulier*. Paris, 1810—19, 4to, Vol. 2. p. 41. sq.) mentions similar cases of wild men being idiots.

From the above examples it is evident that we can give no opinion on this subject with a proper degree of confidence; many of them in fact appear to be fabricated: vide Schreber, *Die Säugthiere*. S. 31. and Blumenbach as above.

From all of these cases, however, it would be extremely ridiculous to imagine that we could perceive in any of them the original state of man.

Rem. 2. The resemblance which it is possible for the skull of an idiot to have to that of a lower animal, may be seen in the writings of Blumenbach, *De anomalis et vitiatis quibusdam nisus formativi aberrationibus*. Gott. 1813, 4to. The passions of the ape likewise, when contrasted with those of the human being, appear to be quite the reverse.

25.

All the many and weighty distinctions between man and the brute creation, including of course the ape, are, without exception, referrible to his destination of living as a rational

creature, while the latter act merely according to sensual impulse, and are completely destitute of the means of arriving at general ideas.

Rem. Many of the otherwise accepted distinctions between man and the brute vanish after more minute and accurate investigation. The hymen, which was formerly considered to exist in the human species only, has already been discovered in the young of many of the inferior mammiferous animals. The catamenia, which was likewise held up as a peculiarity of the human system, has also been perceived to take place in the simia, and the discharge of blood which precedes the time of heat in so many different animals, can only be regarded as a modification of the same thing. And that the sexual desire is not in man, as in other animals, confined to particular seasons of the year, has just as little of a moral tendency as the former. When this periodical desire occurs in animals, it is evidently intended for the protection of the young, which are only able to provide nourishment for themselves at particular times; or it is by this means that a limit is set to too great an increase, as, for instance, in beasts of prey. In many animals, the time of heat returns several times a-year; domestic animals can become pregnant at either time. The brute varies from the human species in a remarkable degree in the manner of bearing their young. Vide J. Günth. Eberhard, *Verhandel- ing over het Verlossen der Koeijen*. Amst. 1793, 8vo, tabb.—R. Bland, *Observations on Human and Comparative Parturition*. Lond. 1794, 8vo. J. Chr. Gottfr. Jörg, *Anleitung zu einer rationellen Geburtshülfe der landwirthschaftl. Thiere*. Lps. 1808, 8vo.—Edw. Skellet, *On the Parturition of the Cow*. London, 1811, 4to, tabb. Ge. Wilh. Stein, *Der Unterschied zwischen Mensch und Thier im Gebären*. Bonn. 1819, 8vo.

26.

Of the whole tribe of Mammalia the erect attitude is natural to man alone, and this consequently on account of his construction, which we find to be the case in all nations without exception, even when living in the greatest barbarism.

Rem. 1. If we examine man and various other animals in various positions, we immediately perceive that his centre of gravity is in the erect position, that of the brute, on the contrary, in the horizontal, or when placed on four feet. Apes, makis, bears, and other animals, can walk a short time on their hinder feet, but then their line of gravity is distorted, and they easily fall down, or they require a support. Even when they sit in the erect position they require some help, as for example, that of the tail.

The whole skeleton of man is arranged for the erect attitude; which is evident from viewing the vertebral column from the top to the bottom, according to the form and connexion of its parts; the cavity of the chest; the pelvis, which is similar to that of no other animal; the connexion of the extremities and of their parts, of the knee, of the sole of the foot. The position of the muscles, for example, the buttock, the back of the thigh, the muscles of the calf.—The situation of the heart, the distribution of the blood vessels.—The connexion and situation of the intestines, of the parietes of the abdomen, &c.

Ger. Vrolik, de homine ad statum gressumque erectum per corporis fabricam dispositio. L. B. 1795, 8vo. Also Bakker, l. c. where the skeleton of an animal is imitated from that of a man placed on the four extremities, in order to shew clearly the falsehood of the assertion, that man was intended to go on four extremities.

Rem. 2. When it is said that man is liable to more diseases from going erect, than the brute from the horizontal posture, it is forgotten that the disadvantages arising therefrom are much fewer than the advantages which it brings with it. The question also can only be—Would man, if he went on four extremities, constructed as he now is, be liable to fewer diseases than when going erect? and this certainly no one would assert. How quickly does the determination of blood to the head become unpleasant, and even dangerous, when it is inclined!

27.

Man, ordained for erect progression, required only two feet, which, in order to move the body with ease, contained firm joints and powerful muscles; the superior extremities

were provided with artfully constructed hands, and fingers for touch, and that the arms might be used the more easily, the joint of the shoulder was remarkably free.

Rem. The importance of the freedom of this joint, which no other creature in the world enjoys to such an extent, is so much the greater on account of the instrument of the organ of touch being situated in it, which is almost peculiar to man. The ape has four hands, yet are all the four very deficient when compared with our two. Men who are born without hands, have but a poor compensation for them in their feet, which by practice are frequently so much developed.

28.

The head of man rests with the middle of its base situated on the vertebral column in its centre of gravity, and therefore a very strong ligamentum nuchæ is not required. In brutes, on the contrary, the foramen magnum is placed the more posteriorly, according to the more erect figure of the neck.

Rem. It is incorrect to say, that the foramen magnum falls the more behind as the animal descends from the human figure, or is lower in the scale of creation, for animals which resemble one another least, correspond in this.

Daubenton sur les différences de la situation du grand trou occipital dans l'homme et dans les animaux. Mém. de l'Ac. des sc. Paris, 1764. p. 568—575.

29.

The brain being the seat of the mind of rational beings, acquired a greater preponderance over the nerves and spinal marrow, and no one sense was developed in preference to the others.

Rem. 1. Man, when compared with other animals, exhibits the largest brain, together with the finest or smallest nerves. S. Th. Soemmerring, vom Bau des m. K. 2. Ausg. 1. Th. S. 85. There is a confirmation of this position in J. Godofr. Ebel, Obs. neurologicæ. Traj. ad V. 1788, 8vo. recus. in Ludwig Script. neurol. minor. T. III. p. 148.

Rem. 2. We find that the organ of smell in animals is pre-eminently developed. In this particular they greatly excel man; but he surpasses them on the whole, by the uniform developement of all the senses; thus, for example, their organs of touch and taste are rather indistinct, and in many of them particular senses are altogether wanting.

30.

This developement of the brain occasions a greater proportion of skull to the size of the face; man exhibits the greatest facial angle; his cheeks are short; and in the embryo in a natural condition, there is merely a trace of the superior maxillary bones observable; the chin on the contrary projects.

Rem. 1. On the facial-line of Camper, see his work *Ueber den natürlichen Unterschied der Gesichtszüge in Menschen*, &c. Berlin, 1792, 4to. On the consideration of the facial and transverse line of the skull from within: Cuvier *Leçons d'anatomie comp.* T. II. p. 9. On the view of the skull from above (the bird's-eye view as it is called): Blumenbach *de var. nat.*—On various other methods, Wolter Hnr. Crull, *Diss. de cranio ejusque ad faciem ratione*. Groning. 1810, 8vo.

Rem. 2. The small bones, which may be compared to the intermaxillary bones (*ossa incisiva*), remain separate in the human embryo as long as the fourth month. A trace or symptom of them frequently appears behind the incisors.

Sometimes they develop themselves preternaturally, and thereby form a double hare-lip: I have however up to the present time always found in the projecting piece of bone an incisor tooth on each side. Some trace of the knowledge of the intermaxillary bones may be found in Rob. Nesbitt's *Osteogeny*; Goethe then became acquainted with the circumstance, and although he caused it to be greatly spoken of, it was but lately that he wrote on it: *Zur Naturwissenschaft überhaupt, insbesondere zur Morphologie*. 1. 2. Stuttg. 1820, 8vo. S. 201. Further, I. H. F. Autenrieth, *Supplementa ad historiam Embryonis humani* Tübing, 1797, 4to. p. 66. and J. F. Meckel, *Handbuch der patholog. Anatomie*. 1. B. Lpz. 1812, 8vo. S. 525.—Gotthelf Fischer, *Ueber die ver-*

schiedene Form des Intermaxillarknochens in verschiedenen Thieren.
Lpz. 1800, 8vo.

31.

Man required to be protected by no natural weapons ; as uniform, and consequently limited, they would only have been disadvantageous to him. He daily invents new ones, and subdues all creatures however gigantic, however fearful they may be, and is in the proper sense of the word Lord and King of the creation.

Rem. 1. Homo inermis.—The nails are perceived already in the ape to become claws. The uniform and closely arranged teeth in man (*dentes æquales approximati*) are likewise different in these animals, and even some of them, as the baboon, have the sharp-cornered teeth of beasts of prey.

Rem. 2. Man, on the whole, cannot be called weak in comparison to other animals, and it merely depends on exercise, which is also necessary to animals, that his muscles may acquire a very great degree of strength. To his strength is added a remarkable degree of dexterity ; and in swimming, climbing, &c. he is not inferior to them.

32.

Man enjoys, distinct from all other creatures, an articulate speech, and that in him is universally the case, to the use of which his reason spontaneously leads him, as the construction of his body does to the erect attitude, and which likewise makes equal progress towards perfection with his general developement. If however on account of deafness, &c. he cannot avail himself of this vocal speech, the same reason prompts him to invent and to perfect a kind of speech for the sight and feeling (a pantomimic speech), which is also equally unattainable by animals.

Rem. 1. Animals enjoy only limited inarticulate tones, evinced as an expression of pain, as symptoms of general feeling ; and these tones are

also found to be uttered by wild children and dumb people. Some particular animals enjoy such a flexibility of the organ of sound, that they easily learn to utter words after man, but without being able at all to comprehend their meaning. Consult on this subject the general description of the parrot by Buffon.

Rem. 2. Peter Camper (Ueber den Orang-Utang, S. 161.) was of opinion, that the air-bag which stands in conjunction with the Larynx of that animal would prohibit from speaking, even supposing he had the reason to enable him to do so; but Vicq. d' Azyr, Oeuvres T. V. p. 308. has very pointedly opposed such an opinion, and certainly with great justice; and indeed Kempelen (Mechanismus der menschl. Sprache. S. 98.) is of opinion that these sacks would rather facilitate than impede speech. J. Lordat (Anatomie du singe vert. Paris, 1804, 8vo. p. 80.) who has also opposed the opinion of Camper, very justly observes, that monkeys can never speak, because they have nothing to say. Mechanical obstacles are certainly not blameable for the want of speech in animals.

Rem. 3. The idea of a primitive language, as accepted by Court de Gebelin (Hist. naturelle de la parole. Extrait du Monde primitif. Paris, 1776, 8vo.) is evidently self-subversive. It would be unaccountably difficult to trace out all the many particular causes, which would conduce to the decided formation of one particular original tongue.

Herder's Abh. über den Ursprung der Sprache. Berlin, 1772, 8vo.—Monboddo von dem Ursprung and Fortgang der Sprache. a. d. Engl. Riga, 1784, 85, 2 Tble. 8vo. with a learned preface by Herder.—There is much excellent matter relating to this subject, in a paper read before the Academy of this city by Wilh. Humboldt, which appeared in a late volume of their writings.

33.

Man being provided with reason, knows how to adapt his mode of living to every climate; he therefore propagates his species more easily than any other creature, and degenerates less.

Rem. 1. The man who will pursue the same mode of life in tropical countries, as he has been accustomed to in the north, will soon sink

under it, and it is by this and excesses of all kinds that so many Europeans are annually snatched away. But if he clothe himself in a manner suitable to the country, enjoy moderately the proper food, &c. he will be able to undergo the greatest changes of abode.

Rem. 2. Less importance ought to be attributed to the pretended softness of the cellular tissue of man, as the reason of his easily suiting himself to various climates (Blumenbach de gen. hum. var. p. 46.), than to his capability of subsisting on various kinds of provision. But this is not owing to any one individual circumstance; he is endowed with reason, and this affords him the means of obviating every evil; domestic animals also, when under his direction and care, can endure the influence of foreign climates to a great degree; still, however, they suffer much sooner than he does.

34.

The brute arrives early at the perfection of corporeal organisation, becomes early subject to sexual desire, and quickly arrives at the summit of all the art he will ever be master of. The childhood and youth of man are long; and it is late before he arrives at manhood; he possesses no innate powers of art; the sphere of his knowledge extends itself during the whole period of his life, but his spirit is never satisfied, and he hopes to arrive at a higher degree of knowledge in another world.

Rem. 1. How late is it before the human skeleton is perfected, how early that of the brute! how short is the infancy of the brute, even of the longest-lived, for example, of the elephant, of the bird, of the fish; that the latter of these (as some indeed assert, but certainly with impropriety) continually enlarge, proves nothing; for all the parts of their body are, notwithstanding, developed at an early period. How early does the horse learn to stand and walk, when it has scarcely been an hour in the world; this happens still earlier with little animals, as the Guinea-pig. In those animals which bring forth many young at a time, and which are born with the eyes shut, this condition lasts only fourteen days at the most, and this is longer or shorter according to the greater or lesser

number of their young. That the Opossum brings its young into the bag in so imperfect a state, in which bag the mammæ are situated, is likewise according to Smith Barton (Facts, obss. and Conjectures relative to the Generation of the Opossum), in order that they may be immediately afterwards impregnated, and have young in the womb at the same time they have older ones at the breast in the bag. Thus the hypothesis of Geoffroy falls to the ground, who lately attempted to demonstrate this sack to be a real uterus, vide Journal. compl. Mai 1819, p. 193.

Rem. 2. It is also erroneous to say that man, from the time of impregnation till that of birth, undergoes various degrees of the animal. In the first germ he has the peculiar designation to become man, as the germ of the elephant, to become an elephant, &c. Through the distribution of his peculiar nervous system, he is likewise distinguished from all others, although he has many parts developed in an equally limited degree with other embryos. The earliest embryo, on account of its completely diversified appearance in external form, is distinguished by the unsuitable name of maggot (*Galba*), which is widely different in all its parts. Other comparisons to the *Amphibia*, *Cetacea*, &c. are of as little import, as they are all drawn from remote analogies between individual parts.

35

That unquenchable thirst after the knowledge of all that is in heaven and on earth, infinitely characterizes man, and the same may be observed with regard to a sense of duty, which he alone can attain, and the voice of which he is seldom able to suppress. The brute, from the fear of punishment, can be taught to do some things or to leave them undone, but it can never attain a sense of what is just, and can neither be virtuous nor base.

Rem. Here also it is evident, that the brute can never arrive at general ideas, but still has something of the civil actions of man in so striking a degree, that it merited to be particularly mentioned.

36.

Diseases for the most part are common to man and other

animals; such alone are peculiar to him, as are referrible to his more developed, and consequently more easily injured, organ of sense, and to his more active nervous system, viz. some diseases of the brain, as Amentia, Hypochondriasis; Intermittent fever.

Rem. 1. Intermittent fever cannot be mentioned altogether with certainty; I know, however, of no example of it in any brute. Animals are often very sad, or even die from melancholy on account of the loss of their master, or of an animal which has through sexual impulse or habit become indispensable to them. Bougainville's parrot is said to have become mad through the noise of a naval fight. Falcons, in order that they may be more easily broken in, are brought to a state of forgetfulness, bordering on stupidity, sometimes called madness. Catalepsy, Epilepsy, Tetanus, Trismus and Mania, are also often observed in animals; the same may be said of Scrofula, Tabes dorsalis, &c. Those eruptive diseases formerly believed to be peculiar to mankind, as Pox, Measles, Scarlet fever, &c. are now observed to affect animals, and to affect the latter when they leave the former. The plague is common to them. Many worms which infest the human subject, also present themselves in animals, as the *Ascaris lumbricoides*, *vermicularis*; *Strongylus Gigas*; *Distoma hepaticum*; *Cysticercus Cellulosæ*; and perhaps also the *Filaria medinensis*.

Rem. 2. The question is, Is there any *organic* disease peculiar to man? Among congenital mal-conformations, the absence of the anterior parietes of the bladder and its anterior covering (formerly erroneously denominated Prolapsus of the inverted urinary bladder) appears at least to be peculiar to the human body, which, as Blumenbach (de gen. hum. var. p. 61.) properly observes, is demonstrated by the peculiar construction of the human pelvis. The inversion of the ribs backward is, on the contrary, a disease which I have seen only in animals (four times, at present only in calves.)

Rem. 3. Besides these circumstances, it is necessary for us to keep in mind, that one and the same disease may appear in the same or in other animals under different forms, for example, Malanders and Cow-pox; Glanders, Whitlow; &c. The same thing may, perhaps, be said of the

plague among cattle, which has only, as yet, been observed in the ox and buffalo. There is notwithstanding, a good deal which may be said to be peculiar to certain genera, for example, Hydrophobia to the canine race (wolf, jackal, fox, dog), for it still remains extremely doubtful whether or not cats and other animals ever become primitively affected with the true Hydrophobia.

A. G. (Peter) Camper's *Abhandlung von den Krankheiten, die sowohl den Menschen als den Thieren eigen sind*. Lingen, 1787, 8vo.—Ern. Ludw. Wilh. Nebel, *Specimen Nosologiæ brutorum cum hominum morbis comparatæ*. Giess. 1798, 8vo.—Theoph. Hnr. Bergmann, *Diss. sist. primas lineas pathologiæ comparatæ*. Gott. 1804, 8vo.—Gaet. Gandolfi, *Cenni di confronto tra le malattie dell' uomo e dei bruti*. Opuscoli. T. 1. Bologna, 1817, 4to. p. 357—72.—Nic. van der Hulst, *Diss. de homine reliqua animalia intensiva vitæ duratione superante*. Harderov, 1811, 4to.

Jac. Guil. Callenfels, *Diss. de homine vi fabricæ suæ minus quam vulgo creditur præ animalibus ad morbos proclivi*. L. B. 1815, 4to.

37.

It is evident from the preceding observations, that man distinguishes himself from all other animals, and when considered as a rational and civilized being, he appears to be distinct from all in an equal degree.

Rem. However great a value I may place on the researches and assiduity of Gall, still, I cannot by any means agree with him in drawing such a level between mankind and the brute. There is a vacuum between them which can never be filled up.

CHAPTER II.

OF THE VARIETIES OF THE HUMAN RACE.

38.

The inhabitants of the whole earth partake equally of the above mentioned distinctions from brutes, and belong collectively to one genus; they differ, however, from one another in the greatest diversity of circumstances: in their size; in the appearance of the body in general, or of its parts; particularly of the skull and face; in the texture and colour of the skin and hair; and perhaps even in respect to mental developement, which does not appear in all nations to be equally great.

Rem. The chief sources of information respecting the subject of this section are—the various journals of travellers, and the writings mentioned, 20. We may also mention in particular, Chp. Meiner's *Untersuchungen über die Verschiedenheit der Menschennaturen in Asien und den Südländern, in den ostindischen und Südseeinseln.* Tübing. 1811—15. 3 Thle. 8vo.—Sim. Thom. Soemmerring *über die körperliche Verschiedenheit des Negers vom Europäer.* Frkf. a. M. 1785, 8vo.

39.

Stature is one of the most variable, and consequently one of the most trifling distinctions; still however, we find generally that it increases in those people who dwell between the temperate and frozen zones. The Tehuelhets or Patago-

nians arrive at a greater stature than any other people ; they are from six to seven feet high. The shortest are, the Esquimaux, Laplanders, and the lately discovered arctic Highlanders ; they seldom or never exceed five feet in height.

Rem. 1. The Patagonians were formerly considered to be much higher than they actually are. The above assertion is attested by Thom. Falkner, who lived among them forty years.—*A Description of Patagonia*, Lond. 1774, 4to, p. 111. Concerning the arctic Highlanders—see J. Ross, *Voyage of discovery to explore Baffin's bay*. On the Esquimaux—Blumenbach, *de gen. hum. var. nat.* p. 260.

Rem. 2. When a certain increase or diminution in stature predominates in a whole race of people, this peculiarity is only to be sought for in the greater or less developement of all the parts with respect to their length, although the more diminutive have proportionably larger heads, while those who are tall have generally a long neck. In tall individuals there is generally some one part which is particularly elongated. Thus, there is the skeleton of a man in our museum, 7ft. 3in. high, which has six lumbar vertebræ ; the great length however, of this skeleton, is occasioned by the particular length of the inferior extremities ; there is another skeleton in the same place which is seven feet high, and this is occasioned by the great length of the spine. Guil. Fr. Leop. Zitterland, *De duorum sceletorum prægrandium rationibus*. Berl. 1815, 8vo.—The assertion in *The Present State of Peru*, (Lond. 1805, 4to. p. 52, Tab. 3.) that a man 24 years of age, named Basilio Huaylas, who was seven feet two inches high, had so extremely large a head in proportion to the rest of his body, that he appeared quite a caricature, appears too extravagant and extremely improbable.

40.

The figure of the body in individual races of people is a good deal diversified, and indeed more so than is at first sight imagined ; there is however, in particular races, unquestionably a predominating agreeable aspect, a greater proportion in the figure, a firmer and stronger build, and so on through va-

rious degrees, until we arrive at the greatest degree of deformity in the southern negroes.

Rem. 1. A troop of Calmucks surprises one, who is not accustomed to them, so much, that he at first believes them to be all alike, until by degrees he begins to distinguish their peculiarities. The same thing happens to them when they see many of us together. In a flock of sheep we believe that they are all of the same exact form, &c.

Rem. 2. Who does not here call to mind the noble form of the Greek, by the recollection of which Denon (Voy. p. 61. Tab. 106. n. 1. 3. 4.) recognized their descendants. The forms of the northern inhabitants of Europe, although less elegant, are notwithstanding, very fine and athletic, as are also the Negroes on the western coast of Africa, the south-sea islands, &c. the beauty of whose forms was, however, greatly exaggerated, as was formerly the case with the inhabitants of Georgia and Mingrelia. The Papua race are the most deformed set of people on the earth, not only on account of the remarkable negro-shape of their faces, but more particularly on account of their very long and thin extremities: Péron, Voyage de decouvertes aux terres australes. T. 1. Paris, 1807, 4to. Tab. 15 & 20.

41.

The most striking marks of distinction exhibited between the various races of men, consist in the configuration of the head, as all the parts of the skull, and particularly the forehead, are either very much developed, or the latter recedes, and the skull is laterally compressed; in some the inferior maxilla projects, and in others it recedes. These varieties in the form of the cranium are not gradually produced, but they are already evidently established in the fœtus.

Rem. 1. See the writings cited in Rem. 1. 30. and also J. Fr. Blumenbach, Decas I—VI. collectionis suæ craniorum diversarum gentium illustrata. Gott. 1790—1820, 4to.

Rem. 2. I have never seen a more noble specimen of human construction than the head of an old Grecian in Blumenbach's valuable

collection, and the copy of which (Dec. VI. p. 5. n. 51.) scarcely gives a sufficient representation; on the contrary, there is nothing more brutal than that of a Botocudan (Dec. VI. p. 15. n. 58.) which, when compared with the former, which attains our very ideal, nearly creates shame in our breasts. It is evident from the smallness of the cavity, and the thickness of its parieties, that the brain contained within this skull must have been very small. Soemmerring (vom Neger, S. 57.) asserts that he has found the brain of the Negro as large as that of the European; the testimony, however, does not appear to be great. Mascagni, on the contrary, (Prodromo, p. 78.) has found it to be much smaller.

Rem. 3. Langsdorf (Bemerkungen auf einer Reise um die Welt. I. B. Frankf. a. M. 1812, 4to. in the explanation of the eighth plate) says, "There are two strong glands in the posterior part of the head, as is the case in all Nukahiwahs, which have never, to my knowledge, been observed in any European by an anatomist." These however, can by no means be called glands, but are merely protuberances in the skull, which are situated internally in the fissures of the cerebellum, with the muscles of the back of the head situated externally, which are strikingly illustrated in the tenth plate of Krusenstern's Reise, Fig. 3. 8. & 11. Tile-sius, as he has written me, deduces the projections from the effect of the muscles. I believe that these circumstances would be very frequently observed in ourselves, if we, like the Nukahiwahs, were accustomed to have the head uncovered. Vide Gall, tab. 30. J. 32. J. 41. 50. t. 62. 63. tab. 99. i.

42.

The form of the skull and bones of the face determines in a great measure that of the soft parts of the countenance, as, in the first place, the situation of the eyes, whether or not they are much separated from one another, with broad Glabellæ, whether they are placed obliquely or straight, further, the position of the nose, the form of the chin, &c. There are other peculiarities which originate in the soft parts themselves, viz. the narrowly separated eye-lids of the Mongols, the thick lips of the Negro, &c.

The skin of man exhibits a great variety of colours : in some it is white, in others it is brown, yellow, red, or black ; and in various degrees in different people. Much of this peculiarity is invariable, and by no means referrible to the influence of climate, but arising solely from causes similar to those from which animals and plants derive their peculiar colours. This is evident from the circumstance of the Negro and American children, being born with the colour peculiar to their race, and likewise from the peculiar organisation of their skin.

Rem. 1. For information respecting the American children, vide Alex. v. Humboldt (Versuch über den politischen Zustand des Königreichs Neu-Spanien, Tübing. 1809, 1. B. S. 120.) “I can assure the reader that the children of Peru, Quito, on the coast of Caraccas, on the shores of the Orinoco and in Mexico, are never white at their birth and the Indian Caciques, who live in houses, and enjoy a certain degree of comfort, are of a reddish-brown or copper colour over the whole body, the palm of the hand and sole of the foot excepted.” The embryo of the Negro likewise, is already destined to take on the form peculiar to their race ; vide Soemmerring, vom Neger, S. 4. According to Phil. Fermin (Beschreibung der Kolonie Surinam. Berlin, 1775, 8vo, Th. 1. S. 108.) the only black part in negro children is the parts of generation, from which it extends itself in a few days over the whole body. Spotted children come into the world distinctly marked black and white, vide Benj. Moseley, Treatise on Tropical Diseases. The same author likewise relates the case of a Negress, who bore a black child and a mulatto at one birth.—H. E. Saabye (Fragments of a journal kept in Greenland, Danish) affirms, that Greenland children at birth are nearly as white as ours, with the exception of a blue spot in the skin, situated on or above the small of the back, and about three-fourths of an inch in size, which afterwards invisibly extends itself over the whole body. He has frequently seen this when baptizing them.

Rem. 2. The colour of the skin arises from its peculiar organisation.

In the Negro it has a particular softness, and imparts a sort of velvet-like softness to the hand, something similar to the dogs of Guinea, the hot perspirations of which are mentioned by J. Nic. Pechlin (*De habitu et colore Æthiopum qui vulgo Nigritæ Liber*. Kilon. 1677, 8vo, p. 57.) and in this particular he compares them to the Negroes.

On the peculiar disagreeable perspiration of the latter, see Hans West's *Beiträge zur Beschreibung von St. Croix*. Kopenhagen, 1794, 8vo, S. 17, 18.—The colour of the skin is partly resident in the cuticle, of which we may easily convince ourselves by applying a blister to the skin of the Negro, by which a black cuticle is separated, as I myself have frequently observed; and partly also in the external surface of the cutis vera (*corium*), which is universally black, as may easily be ascertained by dipping the skin of the Negro in hot water. The latter layer is generally, although improperly, denominated the muscus of Malpighi. We will mention this subject more fully in the special part of the work. Piso (*De Indiæ utriusque remed.* p. 43.) observes: *Anatomix in Æthiopibus exercitii gratia institutæ, certos nos fecerunt, nigredinem illam cutaneam ultra Epidermidem non penetrare, eaque ablata mox ipsam cutem albam Europæarum plane more se offerre.* This is rather going too far.

The skin of the American has not yet been anatomically investigated. Humboldt remarks, when speaking of their peculiar odour, (*Neuspan.* 1. S. 192.) “The castes of Indian or African blood possess the odour which is peculiar to both of these primitive races. The Indians of Peru, who are in the habit of distinguishing at night the different races by their smell, have also three distinct words, signifying the peculiar odour of each; there is one for that of the European, a second for the primitive inhabitants of America, and a third for that of the Negro.”

Rem. 3. On account of the more delicate texture and whiter appearance of the skin of the European, we observe that the blood shines through it at certain parts, as the cheeks, the lips, &c. This cannot easily happen with the Negro, at least I have never found their lips otherwise than of a rusty or clear black colour. Goolberry, however, (*Fragmens*, T. 2. p. 432, 434.) asserts, that he has seen young Negresses where the blood was seen through the cheeks. J. P. Schotte (*Von einem schwarzgalligten Faulfieber in Senegal*) observes, that the petechiæ in purpurea

were not observable in the skin of the Negro. Ransonnet (in Péron, T. 2. p. 155.) examined the inside of the mouth of the New Hollanders, and found it as black as the external skin of their body.

44.

It is a general rule, that the colour of the hair is connected with a similar hue of the skin, and in animals the general horny parts likewise exhibit the same colour, and the cuticle, hair, horns, and hoofs, coincide. Besides this, there are generally other decided peculiarities which happen according to the colour of the hair. The yellow or clear brown hair of the northern Europeans is generally soft and fine; that of the southern Europeans, which is black or brown, is harder and rather thicker; while that of the Hindoos is long and fine; the black hair of the Americans and Mongols is thick and bristly; that of the Negro is peculiarly woolly and tufted.

Rem. 1. The hair of the Americans seldom becomes grey, even at the most advanced age. Mart Dobritzhofer (*Geschichte der Abiponer*. Wien, 1783, 2 Th. S. 56.) appears frequently to have seen Americans who have become grey-haired. Phil. Salv. Giliî saw an old man who had very light yellowish hair. Humboldt (*Neuspan. 1. S. 123.*) says, "Their heads never become grey, and it is infinitely more rare to find an Indian than a Negro, with white hair. Moreover, the skin of the Indian does not so easily wrinkle." In Negro people this appears to vary very much: Denon (*Voyage*, p. 62.) says of the Barabras, that age is only to be known in them by the whiteness of their beards. Marcgrav (in Piso, p. 12.) has seen many Negroes in whom both the beard and hair of the scalp were grey.

Rem. 2. There is a certain disease which appears among all nations, of whatever climate they may be, in which the whole or the greater part of the skin, together with the hair, exhibits a preternatural whiteness, and also the pigment of the eye is quite wanting, or nearly so, so that the pupils and iris appear of a red or violet colour. Such people are distinguished by the name of Albinos, Dondos, Blafards, Kakkerlaken: there are also white Moors who are termed Leucæthiopes, and hence the disease

called Leucæthiopia. As this term, however, is inapplicable, on account that Europeans as well as Negroes are affected with the disease, I have used instead, for many years, the term Leucosis, *Homines leucotici*. Virey has lately adopted the name of Chlorotici, which, according to the analogy of Chlorosis, appears to be very natural (*Journal complém.* T. 2. Cah. 6. p. 104.); but is very wrong when he compares this white disease with the change to whiteness of many animals in the north, for on this the cold has no influence; and compares it with equal impropriety to the Melanosis (blackness of the Negroes), and in representing it as a disease. The Albinos were formerly considered to be a particular race.

Blumenbach, *de gen. hum. var.* p. 274. sq. To this excellent literary production I would likewise add: On the Negro: *Wurmb, Merkwürdigkeiten aus Ostendien*, S. 246. Goolberry, *Fragmens d'un Voyage en Afrique*. Paris, 1802, 8vo, T. II. p. 437. On a white southern Negro: La Billardiére (*Relation du Voyage à la recherche de la Pérouse*. T. 1. Paris, an 8vo, p. 332.) The same author found an Albino at Tongatabu (T. 2. p. 142.)—Ge. Tob. Lud. Sachs, *Historia naturalis duorum Leucæthiopum, auctoris ipsius et sororis ejus*. Solisbaci, 1812, 8vo.

This white disease (Leucosis) frequently appears among the class of Mammalia and birds. I have known no example of it among the cold blooded vertebral animals, unless a citron-yellow coloured frog may be said to belong to this class, which I have seen living a long time, belonging to Meyer (Lecturer on Physiology). This must certainly be admitted to take place among insects, at least the *Silpha livida* appears to me to be a *S. littoralis* of this albino description; the *Coccinellæ* differ in a similar way.

Rem. 3. The brain, semen, and blood of the Negro, were formerly considered to be black, at least blacker than that of Europeans, but this idea has been subverted by more accurate investigation. Soemmerring, *vom Neger*, S. 39. S. 40. S. 55. I have lately dissected a Mulatto, the medullary substance of whose brain was darker than I have ever observed it in Europeans. The anterior lobes were very small. The brain is now in the Museum.

The growth of hair is greatest in Europeans; in others it is much thinner; so that in those Americans who have not intermarried, we find very little hair on the beard, in the arm-pits, and on the parts of generation; the same observation nearly applies to the Mongols, and most other Negro races.

Rem. The beardlessness of the Americans is so generally known and spoken of, that I will merely mention one very valid authority, viz. Dobritzhofer, who lived eighteen years among the Abiponese in Paraguay (B. II. S. 5.). How could it ever be possible for people who naturally have a full growth of beard, to pluck them out? It can only be those who have a few straggling hairs that could ever fall on such a practice. Pallas (Sammlung historischer Nachrichten über die Mongolischen Völkerschaften. 1. Th. Petersb. 1776, 4to, S. 100.) says, "In all Mongolian nations, the male, when in maturity, is by far less frequently seen with a beard, than Tartars and Europeans, and it generally begins much later to grow. The Calmucks, of all others, have the thickest beard, which, however, generally causes them to look badly and thin." He expresses himself in much stronger terms in respect to the Burats, whose chins, even in old age, are quite smooth, although they are never accustomed to extract them.—Likewise Turner on the thin growth of hair in Hottentots (Journey of Embassy to the court of Teshoo-Lama). Vaillant, Voyage dans l'Intérieure de l'Afrique. A. Liège, 1790, 8vo, T. 2. p. 107.

The Europeans appear to excel all other races in muscular strength; the greatest debility is found among some Mongolian and Malay nations.

Rem. For a very praiseworthy series of experiments with Regnier's Dynamometer, we are indebted to the celebrated Péron (Voyage, 1. S. 446—458.); a closer analysis of the instrument, accompanied with drawings, may be found in Dict. des sc. médi. T. X. p. 303. By the above experiments the great superiority of Europeans is demonstrated, contrasted with the inhabitants of Timor, New Holland, and Van Diemen's

Land. On the almost incredible lightness and weakness of the Mongols, see Pallas, *Mongol. Völk.* 1. S. 171. On the limited strength of the Negro: West, über St. Croix, S. 18. Still, however, there are very powerful individuals among the Negroes, and Humboldt (*Neuspan.* 1. S. 103.) has related examples of the great muscular power of Mexican mine-labourers.

47.

But it is not in a corporeal sense alone that the races of men are various; they also seem to vary much in respect to intellectual powers.

Rem. 1. Pauw and Meiners went too far in extolling so high the superiority of particular races of men; but perhaps they erred just as much, if not more, who considered that the same degree of intellectual power existed in all the species. The individual examples of Negroes becoming accomplished under foreign instruction, are indeed very weak objections; and in vain do we see, in the following work, every thing summoned together, in order to represent the Negro as equal to the European.

H. Grégoire, *De la Litterature des Nègres.* Paris, 1808, 8vo.

Rem. 2. It is impossible that the form of the skull can arise from any other cause than the particular figure of the brain, on which certain degrees of developement depend. When the anterior or lateral parts of the brain are less extensively developed, or if the whole cerebral mass be smaller than usual, it must of necessity have its consequences. In treating of this part of anthropology, we are obliged to confine ourselves to the figure of the skull exhibited by the various stocks of men, because, excepting that of the Negro, we are entirely ignorant of the form of their brain. A great deal, however, may be gained from the examination and comparison of the skull, and the histories of people who have been known for thousands of years, afford us data which we cannot despise.

48.

The above-mentioned marks of distinction (39—47.) sometimes present themselves individually, and in that case they are

of little importance ; generally, however, more of these peculiarities appear in a certain determinate connexion, and seem to be invariable in certain stocks, so that we distinguish them as their essential characteristics. The Negro, for example, is not only black, but his skin is lubricated by a peculiar perspiration, and is particularly soft to the touch ; his hair is woolly ; his scull is laterally compressed ; his front recedes backward ; his jaws project ; the nose is turned up, the lips thick, &c. Perhaps his parasites are also different.

Rem. 1. J. Chr. Fabricii, *Systema Antliatorum*. Brunsv. 1805, 8vo, p. 340. n. 2. *Pediculus Nigritarum*: ater, capite triangulo, corpore rugoso. Hab. in Nigritarum corpore. Dom. Smidt. Mus. Dom. Lund. Paulo minor *P. humano*. Caput magnum, læve, triangulum, antice subbifidum, atrum. Corpus subrugosum, atrum, immaculatum.

Rem. 2. *Bothriocephalus latus* (*Tænia lata* Linn.) is found to infest the bodies of the Russians, neighbouring Prussians, and Swiss ; while in the other Europeans and Greeks, *Tænia solium* is found. I have only seen one example, in a young female, where both of these presented at the same time, but it is probable that this person was of mixed descent. We are altogether unacquainted with the intestinal worms—tape-worm, &c. of the Americans. Ch. Capotin, (*Topographie médicale de l'île de France*. Paris, 1812, 8vo, p. 145.) asserts indeed, that tape-worms are exceedingly obnoxious to the Negroes, but he does not mention their species.

49.

Heretofore authors have attempted to explain each of these variations independent of their other concomitants, and without taking them at all into consideration, or remembering that by such a mode of proceeding no advantage is gained. It is by the consideration of these circumstances collectively, that we are enabled to arrive at any just conclusion.

Rem. 1. One author, for example, chose the colour of the skin for the subject of his enquiry ; another, the features of the countenance, and shewed that variations in this respect presented themselves in one and

the same tribe of people: but how all these were united in one race, as is the case with the Negro, was altogether overlooked. It is impossible that a Negro can ever appear among Europeans as a variety of the same species.

Rem. 2. The Essay of Sam. Stanh. Smith on the causes of the difference of colour and form of the human species, where he attempts to prove that the form of the face and scull of the polar inhabitants is produced by the operation of cold, appears to me to be one of the most unfortunate hypotheses.

50.

By such representations they have arrived at the conclusion, that the inhabitants of the whole earth are the descendants of one original pair, which were of European form; although to support such a supposition, they are able to adduce no other authority throughout, than a very improbable Jewish tradition.

Rem. 1. It would be ridiculous to imagine that scientific views were the objects of revelation; every scientific observation therefore, which presents itself in this work, is the critique of the science to which it particularly belongs, but quite independent of theology. The same thing has been universally maintained by astronomers, and has been inculcated even by theologists; for example, Pott, in his work entitled *Moses und David keine Geologen*. Berlin u. Stettin, 1799, 8vo.

Rem. 2. Were Negroes to write on the subject of Anthropology, they would doubtless prove by similar arguments that the European and other races were but descendants from them—the original or parent stock of mankind. Indeed it has been already contended by Pallas, as highly probable, that the black race has become ennobled, and thus produced the European; and Schelver and Doornik have treated this circumstance in favour of the Negro with the greatest assiduity. But the one is equally as unlikely as the other. H. F. Link (*Die Urwelt und das Alterthum erläutert durch die Naturkunde*. 1 Thl. Berl. 1821, 8vo. p. 117—141. *Die Verbreitung des Menschen*) considers the Negroes as the original stock, who were afterwards divided into three principal races, viz. the

Negro, the Mongolian, and the European. *Heinr. Steffens*, in his *Schriften*. Bresl. 1821, 8vo, 2 Th. p. 218—264, attempts to explain the varieties of the human race as being produced by their original transgression.

51.

The possibility, that five hundred millions of human beings, for there may be about as many inhabitants on the earth, are descended from an individual pair, certainly cannot be denied, but it can only be through a chain of wonders that such a circumstance is at all probable. Accidents of all descriptions, diseases, injuries, &c. could have happened as easily to a first couple, as to their descendants, and thus, so important a circumstance as the peopling of the earth, would have been altogether left to chance. In such a way nature never goes to work, and in nothing does she shew herself less incautious, than in the means she employs to preserve a species or genus.

Rem. In the *Almanach Impérial* for 1810, the population of the earth is said to amount to 907,000,000; In *Zeunés Göa* (Berlin, 1811, 8vo.) to 883,070,000 persons; but it is evidently estimated too high, as they have been too liberal to China in particular. The calculations of *Volney* appear to be well entitled to belief, (*Traité du Climat et du sol des Etats unis de l'Amerique*) according to which there can scarcely be reckoned five hundred millions of people.

According to *Stein* (*kleine Geographie*. Zehnte Aufl. Berlin, 1819, 8vo, S. 17.) there are 705,879,600 inhabitants on the earth; according to others 1000 millions, of which 170 are calculated to be in Europe, 550 in Asia, 150 in Africa, and in America 130 millions.

52.

Population rises and falls. Nations, like individual families, flourish for a time, and pass again into oblivion. A few thousand years ago perhaps as many people were in existence as

at the present time, but only otherwise distributed; and the same policy of nature which regulates the mass of all animals and plants, evidently affects the human species in the same way.

Rem. 1. The race of Guanches and Caribs are now nearly extinct; and there are now but scanty remnants of the ancient Egyptians, and many South American nations. Tahiti will perhaps in a short time be deprived of its inhabitants. What is Italy now to what it formerly was? What are North Africa and Greece? While on the contrary, so many European states increase in population, and North America daily develops new forces.

Rem. 2. Nothing is owing to accident or chance, and thus the equilibrium of the population of the earth maintains itself, taken as a whole, according to certain laws. An excess of population would presently be productive of such consequences, contagions, wars, &c. that the evil would soon be remedied. There exists likewise on the earth, as a whole, a great equality in the proportions of male and female births. Hufeland, über die Gleichzahl beider Geschlechter im Menschengeschlecht. In den Schr. der Ak. der Wiss. zu Berlin, für 1819, S. 151. u. folg.

Rem. 3. If we admit, that from two persons, five hundred millions are descended in the course of six thousand years, how very different must the increase of population appear from that which we have been taught by the experience of all ages!

53.

From the hypothesis, that all the people of the world are descended from one couple, and also distributed from one spot of the earth, we can gather throughout no reason which could incite mankind so early to leave their place of nativity, or what could have enticed them through wastes of country and over great oceans. We might then with equal justice admit the origin of beasts and plants in one place, for the one could scarcely happen without the other.

Rem. 1. The resistance shewn by plants and animals to migration evinces itself more plainly, as they are almost all confined to certain, sometimes to very limited, places of abode. And the same may, in a general sense, be observed with regard to man. Vide E. A. W. Zimmermann's *Geographische Geschichte der Menschen und der allgemein verbreiteten vierfüßigen, Thiere*. 1—3. Th. Lpz. 1778—83. 8vo.—Rudolphi's *Beitr. zur Anthropologie*, S. 107—172. Ueber die verbreitung der organischen Körper.

Rem. 2. The migrations of nations which are known to us, have availed little in explaining the peopling of the earth, at least they throw little light on the distribution of the human races.

54.

The supposition that all the people of the earth are descended from an individual pair, is completely erroneous, when we take the varieties they present into consideration. Nations which have remained unintermingled, even in the most opposite climates, have never been known to degenerate. Negroes, as far as history goes, have always been the same, and still remain so, both in America and Africa. The Jews and Gipseys still retain the traits of their original descent. Europeans, when in other regions, will never become Negroes, Malays, &c.

Rem. 1. I shall out of many examples quote only one, Geo. Pinkard (*Notes on the West Indies*. Ed. 2. Lond. 1816, 8vo, Vol. I. p. 310—313.) saw an English family in Barbadoes, of which the children formed the sixth generation, and who did not in the least differ from Englishmen. Demanet's fable respecting a colony of Portuguese in Africa having become Negroes, has been completely disproved by Blumenbach, (*de gen. hum. var.* p. 128.)

Rem. 2. The supposition that mankind were originally all alike, but that they soon afterwards became degenerated, as we see them at present, is altogether arbitrary, and requires no comment, as they can give no reason

for supposing that a change of the species could have been produced at that particular time, and never afterwards.

55.

The fecundity of those who are the offspring of individuals of different races, affords us throughout no proof of their common origin. How is it, that many similar, and certainly prolific, animals and plants, never appear in certain places, except when conducted by us from a certain spot? And what should impede the same thing from taking place in many other points under similar circumstances?

Rem. While we observe the same intestinal worms presenting themselves in foreign animals, even when in their native regions, as with us at home, can we for a moment suppose that these are local? The same thing may be observed not only with regard to the infusoria, fungi, and musci, but likewise of higher organised beings, the same species of which may be produced in many different places.

56.

That the sexual intercourse of individuals of different tribes of mankind is prolific, goes just as little to prove them of one species. If we even admit it as an exception with regard to animals, which in a state of nature copulate with their own kind only, this in the first place proves nothing with regard to man; and secondly, we know very little of the dispositions or feelings of mankind in such a savage state, or where such a thing does happen, he likewise adheres to his own race. The same disposition also frequently exists even in cultivated nations, at least we generally choose those of our own nation in preference to others.

Rem. 1. It is likewise an altogether arbitrary hypothesis, that the copulation of animals of the same species is alone successful in impregnation, or that the young of a mixed breed remain barren. The interming-

ling of sheep with goats is well known: there are numerous other examples of this, which may be found in my *Beiträge zur Anthropologie*, S. 160—165. I shall here only name two authorities on this subject: Balth. Sprenger, *Opuscula phys. math.* Hannov. 1753, 8vo, p. 25—48. *De avium hybridarum virtute generandi usque ad tertiam generationem observatio.* Likewise Hellenius's interesting experiments, where a roe was impregnated by a ram, and produced young which were likewise fecund, and which at length became common sheep: (*Vetensk. Ak. Nya Handl.* Stockh. 1790 and 1794. Further, *Cogitationes quædam de Animalibus hybridis.*) Aboæ, 1798, 4to.

Were we only to admit those animals of a genus as species of the same, which we had ascertained to be unfruitful after copulation, it would be in our power to mention very few, for in how many have we ascertained this as a fact?

57.

When the same thing which serves for our guide through the whole range of natural history, is found to be easily applicable to man, we cannot avoid dividing the human race into different species. Indeed the characteristics exhibited by the different tribes of men are so evident and invariable, that it would be very desirable to have such valid marks of distinction in all other animals.

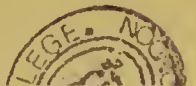
Rem. 1. It is improper to consider mankind as all of one species on account of the transition observed to take place from one race of the same to another, for this is acting in contradiction to the principles adhered to in every branch of natural history; for almost all the admitted species of animals and vegetables exhibit similar transitions to those species which are most nearly allied to them.

Rem. 2. The terms Race and Variety, which are generally employed to signify the species of man, cannot be approved of, as it presupposes something erroneous, at least something which can never be proved with regard to the common origin of man from the same parents.

At how many different parts of the earth Autochthones (*Aborigines*) were formed, is a circumstance which will never be determined; and, as has already been observed, 55, this would contribute nothing to identify the species. Every classification must be liable to error, both from the intermixture of the different tribes with one another, and also from the very unsatisfactory information we have respecting so many of them, whether as regards their language, or their form, or both.

Rem. 1. In the present state of our anthropological knowledge, it is certainly to be considered as highly proper that we should choose the form of the body as the justest grounds of classification, and according to this principle, to classify all tribes of people in a method similar to that pursued in the other branches of Natural history, without taking into consideration the countries which they inhabit. The colour was formerly held as the only ground of classification, which alone, however, was not sufficient. From the comparison of their different languages, there is still less information to be acquired, as this is a subject which has not, until lately, begun to attract attention.

Rem. 2. The greatest part of the narratives of old travellers concerning the various nations which they visited, are nearly as useless as the plates which they contain. Even the numerous drawings of savages, executed by or represented in the works of later travellers, are of very little value; either the imagination of the artist has been too much employed, as is the case in Cook's Voyages, or sufficient attention has not been bestowed on distinguishing their peculiarities, as in Symes, Bowden, &c. But, if we had a few travellers who, possessed like Denon of that nice spirit of enquiry and discrimination, could discover the peculiarities of nations, how soon would Anthropology merit to be classed with the other branches of Natural history, instead of being delivered in fragments, as is done at present.



The principal marks of distinction which present themselves in the human race, are found to exist between the European, the Mongol, the American, and the Negro.

Rem. Blumenbach distinguishes mankind into five varieties, viz. Caucasian, American, Mongolian, Malay, and Ethiopian. The Malay variety adopted by Blumenbach, appears to me to be a mixed race, vide 60. C., 61. *Rem.* 3., 62. *Rem.* 1. It will perhaps in process of time be possible to arrange all individual nations with one another, according to the relations exhibited between them; at present it is one of the most interesting, and at the same time, most difficult undertakings.

60.

The European race distinguishes itself by the particular developement of the (brain and) scull, by means of which the forehead is arched, while the lower jaw and cheek bones exhibit little or no prominence. The growth of hair over the whole body, and particularly the beard, is stronger than in any other stock; the hair of the head is soft, sometimes in locks, but never woolly. The colour of their cuticle is whiter than that of the others, so that even those who generally appear brown, as the Moors, become white when confined to the house; thus the blood shines through the skin, and reddens the cheeks and lips, particularly the latter. I would consider as belonging hereto:

A. All those nations situated in the neighbourhood of Europe. Blumenbach (*de gen. hum. var. nat.* p. 290, 292.) comprehends the Finlanders and Laplanders under the Mongolian variety, but I feel myself authorized to assert that it is with great impropriety. I have seen many Finlanders, and also some Laplanders, but have never been able to observe any thing in their structure which could authorize us to consider them as Mongolians. Nor has this been attri-

buted to them by later travellers, although the Finlanders and Laplanders have been considered as different people.

B. The inhabitants of the highest northern latitudes, who are not mixed. They are evidently something allied to the Laplanders. The bearded, white skinned Esquimaux, together with the Greenlanders, and lately discovered arctic Highlanders, and Tschuktschi, are unquestionably to be excepted from the Mongolians, among whom they have also been classed by Blumenbach. For further information respecting the Esquimaux, see Erich Pontoppidon's *Versuch einer natürl. Historie von Norwegen*. Kopenhag. 1754, 8vo, 2 Th. S. 434.; also David Cranz, *Historie von Grönland*. Berlin, 1765, 8vo, S. 331. where he compares the Greenlanders from North America, with the inhabitants of North-east Siberia, but not with equal success throughout. The Tschuktschi are, by Humboldt (*Reise*, II. S. 249.), denominated Asiatic Esquimaux. In the *Journal of Discovery to explore Baffin's Bay*, by John Ross, there are figures of two arctic Highlanders (Pl. 11, 12.), and of a young girl (P. 5.), whose father was a Dane, and the mother an Esquimaux, these are evidently European countenances, having the eyes very closely approximated. The excellent figures of the Ainos by Tilesius, in the *Atlas to Krusenstern's Reise*, Pl. 77, 78, 79. Fig. 1—4. Fig. 7—9. represent bearded European countenances (*of Slavonic origin*). The same may be remarked of the Kamtschatkans in Pl. 31. Fig. 7, 8. of the same work; but in these there might have been a considerable portion of Russian blood. The Alleutians, on the contrary, are evidently Mongolian.

C. A great many of the nations of western, and even some of southern Asia. Blumenbach refers all Tartars to the Mongolian class, but there are evident marks of distinction among them. Some tribes of them, as the Kirgises and Cal-

mucks, belong to this class ; while others, as the Bashkirans and Tscherkesses, belong to the European variety. A number of Bashkirans passed through Berlin during the late war, but I could detect nothing of the Mongolian structure in any of them. Engravings of the Tscherkesses may be found in Pallas's *taurisch. Reise*, Taf. 18—20. Mountstuart Elphinstone's *Account of the kingdom of Cabul and its dependencies in Persia, Tartary, and India*. Lond. 1815, 4to, contains engravings (Pl. 2—14.) of various Afghans, Doranis and Tartars: they have all European countenances, some partaking more of the Persian, and others more of the Tartar appearance. Pallas (*Taur. Reise*, S. 148, Taf. 12. Fig. 2.) relates, that the mountain Tartars who inhabit some of the villages in Krimm, are extremely hideous. James Morrier's work (*A second Journey through Persia, Armenia, and Asia Minor to Constantinople*. Lond. 1818, 4to, p. 330.) contains engravings representing three Kurdees, with wild, brown faces, and tremendous large noses: but on the contrary, there are other European Tartars who are very finely formed. For the engraving of a beautiful Arab child, vide *Salt*, p. 130. "

The work of Vivant Denon (*Voyages dans la haute et dans la basse Egypte*. Paris, 1802, fol.) contains numerous engravings, of which Tab. 104—112, represent Arabs; 106, Greeks; 107, Turks; all of which are drawn and etched by himself; and what he says in p. 60, 61. is very interesting, and well worth the reading. For further remarks respecting the Jews, vide *Magazin der Naturf. Ges. in Berlin*, B. VI. S. 64.

How far southward the European (*Caucasian*) stock extends, is a circumstance which I am not able to determine; but unless I am much mistaken, a great part of the Hindoos belong to this class; and it is perhaps from the intercourse of these people with the Mongols, that a part of the Malays have

originated ; or it may be, that a part of the Mongols have originated from the intercourse of these with Negroes. I think, however, that these people in their medium form, may very properly be considered as aborigines.

The dark, or indeed the black coloured skin of so many Hindoos, is no obstacle to their being classed with the Caucasians, as their other peculiarities agree much better with this than any other class. And indeed the Virgin Mary, although a Jewess, was formerly painted as being black, and is so still in Loretto. The same may be remarked of all the Jews who inhabit Abyssinia.

D. The European stock is also very widely extended through Africa. The Moors, who inhabit the borders of southern Europe, occupy a great portion of that quarter of the earth. We may also mention the Abyssinians, although at the present day they appear to be nothing more than a mixture of Moors, Jews and Ethiopians. Salt (*Voyage to Abyssinia*. Lond. 1814, p. 458.) very improperly considers them as altogether of Ethiopian origin, and denies that there is any mixture of the Arab in them, but this assertion is disproved by his own drawings: Ayto Debib, an Abyssinian chief (p. 198.), and Guebra Mehedin, an old servant belonging to the Ras of Agora, have complete Jewish countenances, and the same may be said of two other figures in the plate p. 239. The third figure of the plate is certainly not Jewish, but it resembles none less than the Ethiopian ; this is likewise the case with Dofter Esther (p. 333.), who has evidently an European countenance, with a high forehead, long nose, &c. ; the countenance of Berilla, an Edjow Galla (p. 337.), exhibits the sly Arab cast ; and that of the young slave, whose nativity is not mentioned, is Celtic. The figure of the Abyssinian, which is given by Valentia (*Voyages and travels to India, Ceylon, the Red Sea, Abyssinia and Egypt*. Lond. 1809, 4to, Vol. 2. p. 54.), exhibits a Jewish countenance ; and the same may be

said of others, in p. 133, 143, 219. Ras Michael, represented in the frontispiece to the second Part of Bruce's 'Travels, has quite an European countenance, and Bruce mentions that he very much resembled Count Buffon in appearance.—For information respecting the Moors, see particularly Goolberry, P. 1. p. 298, 300, 304—311.

61.

In all those tribes of people, which we consider as belonging to the Mongolian stock, we observe the following appearances—a flat, broad countenance, with a receding forehead; projecting cheek bones; the eyes widely separated from, and standing obliquely towards, each other, with narrow approximating eye-lids; a yellow, yellowish-brown, or dark-yellow skin; black, bristly hair; a thin growth of beard; with a light and slender constructed body.

Rem. 1. The Mongolian variety comprehends—the Japanese, Chinese, Bootanese, Thibetians, Calmucks, Burats, Allettians, &c. Southwardly, this variety intermingles with the Malays, and it becomes a matter of considerable difficulty to distinguish the Javanese and other southern Indians accurately from them. Among the engravings given of the Javanese by Thomas Raffles (*The History of Java*, Lond. 1807, 4to.), there are some, as those in P. 1. p. 84, 318, 320, 342, which appear rather to belong to the Mongolian variety, while others, as in p. 86, 88, 90, 92, 94, on the contrary, exhibit more of the Hindoo appearance. Raffles himself is of opinion, that they approach nearer to the Siamese, than they do either to the Chinese or Japanese.

Rem. 2. The work of J. Barrow (*Travels in China*, Lond. 1804, 4to, p. 50.) contains a plate representing, in contrast, a Chinese and Hottentot, and remarks, that they can only be distinguished from each other by the hair. But the Hottentot, besides the woolly hair peculiar to him, has likewise a broader nose, more prominent lips, and a narrower head, so that, in the end, the position of the eyes and the colour alone remain common to both. The Mongolian and Ethiopian

varieties are without doubt frequently mixed, but notwithstanding, they both appear to me to be so essentially different, that I can on no account consider them as one species.

Rem. 3. The frontispiece to Barrow's Travels above-mentioned, contains the portrait of a Chinese, and in Krusenstern's Atlas there is a remarkably well executed drawing of a Chinese child (Pl. 97.). Plates 50 and 53 of the same work, contain figures of the Japanese; these may be found also in Langsdorf, P. I. Pl. 22—26. There are a few of the inhabitants of Loo-Choo very characteristically figured in Basil Hall's Account of a Voyage of Discovery to the West Coast of Corea and the great Loo-Choo Island, Lond. 1818, 4to; see the plates, p. 16, 96, 132, 215. The figures of Symes represent indeed Mongolians, but they are too much ornamented and softened. The Chinese Tartars of Sachalin may be found in Krusenstern, Plate 83. In the same work likewise Alleutians, Plate 31. Fig. 5, 6. Calmucks in Pallas taur. Reise I. Plate 4, 5. Blumenbach, Naturhist. Abbild. Pl. 1.

The Malays of the islands of the South sea are frequently represented in plates (who may easily be distinguished from the Negroes of the same place), but the figures are very frequently embellished, as is the case in Cook's Voyages; in Parkinson, Pl. 3, 5, 7, and particularly 8, are the inhabitants of Tahiti; Pl. 16, 17, 19, 21, 23, are New Zealanders, which present the very physiognomy of Europeans. There are many of the inhabitants of Nukahiwah in Krusenstern, Pl. 7—10, particularly Pl. 15, with a number of portraits. Malays of Timor in Péron, T. I. Pl. 25, 26.

62.

The Ethiopian variety presents a laterally compressed skull, with a receding forehead; projecting jaw bones, with the chin gradually sloping backwards; a broad, turned up nose; prominent lips; a grey, or black complexion, in which there is seldom a trace of red to be seen; and woolly hair.

Rem. 1. The Ethiopian or Negro variety extends westward from the Moorish tribes to the south side of Africa, and reaches eastward as far as the north coast of Africa; for it is extremely probable that the Copts

in Egypt are the remains of the ancient Ethiopian inhabitants of that country (Denon, p. 59.); I cannot, therefore, agree with Cuvier (*Mém. du Muséum d'Hist. Nat.* T. III. p. 273.), in referring the whole of the ancient Egyptians to the European variety. Blumenbach (*Beiträge zur Naturgesch.* II. S. 130.) has very properly pointed out the physiognomy of three different nations or classes of people among the ancient Egyptians, viz. the Ethiopian, the Hindoo, and one something like the inhabitants of Barbary.

Besides these, the Andaman Islands are well known to be inhabited by real Negroes.

We may comprehend under this head, the Negroes of the South sea, or Papua islands; they do not however appear as a colony, but are, in all probability, an original people; we may, notwithstanding, from their affinity to this species, consider them as a variety of the same.

And lastly, the Malays, who are evidently connected with the Negroes, although their hair is not quite so woolly, and the general characteristics of the Negro are less striking. Blumenbach considers the Malay as a sort of medium between the European and Negro.

Rem. 2. On the Negroes in Senegal, Goolberry merits principally to be consulted (I. p. 100.); next to them the Jalofs are the blackest; in the Mandingas the black begins to assume a yellow cast. He contends that in negresses he has seen the red colour shining through the cheeks, &c. (II. p. 432—434.) G. Mollien gives some very interesting information on many Negro tribes, and also of a real negro race, (*Voyage dans l'Intérieur l'Afrique aux Sources du Sénégal et de la Gambie.* Paris, 1820, Voll. 2. 8vo.) It is very remarkable that he so frequently speaks of the bad teeth of the Negroes, as in Vol. 2. p. 14, 63, 179.

There are drawings of Galla Negroes to be found in Valentia (III. 8vo, p. 143, 150.).

Hottentots in Vaillant, (*Voyage dans l'Intérieur de l'Afrique.* Paris, 1790, 4to,) Tab. 1—4. Tab. 7. and in his *Second Voyage dans l'Intérieur de l'Afrique.* Paris, an. 3. Tab. 10—15.

Of Kaffers in Lichtenstein's *Reisen im Südlichen Afrika.* Berlin, 1811, 8vo, 1. Th. S. 390. u. and Lod. Alberti, *De Kaffers aan de Zuidkust van Afrika.* Amst. 1810, 8vo, with plates of Kaffers, p. 132,

188. Barrow improperly distinguishes them from the Arabs; still however, their mixture with other tribes cannot be denied.

I have lately, through the kindness of Krebs, received a complete Kaffer's cranium for the anatomical museum, of which I intend giving a representation, as well of the head generally, as of the skull in particular. The skull, in most of its parts, resembles that of the Negro; we observe particularly, that the jaws do neither project, nor the chin slope backward so much as they do in the former.

The museum has likewise received the skull of a Hottentot from the same source. That of a Bosjesman was presented to it by Lichtenstein, together with a gypseous cast of another. Of Negroes we have a great variety.

The museum likewise contains the head of an Egyptian mummy (of European race), in as beautiful a condition as we find it represented in the large work on Egypt. It was presented to it by the Baron von Sacken, to whose goodness and liberality it already owes so much. From him also, we expect the skulls of two ancient Greeks, which were dug up at Athens. We have likewise two Guanche skulls, brought from Teneriffe by von Buch: so that, by such liberal support, I am in hopes of soon seeing this part of the anatomical collection equal with the rest.

Excellent plates of the Negroes of the South sea may be found in Péron, T. 1. Plates 8—12. are inhabitants of Van Diemen's Land, and Plates 17—21. represent the inhabitants of New Holland. In the Append. p. 235. T. II. of Raffles, is the portrait of a Papua boy of New Guinea. They distinguish themselves from the proper (African) Negroes, by their greater degree of ugliness and very long thin extremities. Ransonet (in Péron, T. 2. p. 155,) remarks, that the interior of their mouths is as black as the exterior of their bodies.

63.

In the Americans, the skull, as a whole, is not fully developed. The head is in general small, at least in the South Americans; the forehead is low, and slants abruptly backwards; the features of the face are very strongly marked, the

bones of the cheeks project; the hair is black and strong, the growth of the beard particularly thin; the colour of the skin is a bright or dark (copper) red.

Rem. 1. The Americans constitute a great number of tribes, which, however, are akin to one another, and inhabit the whole of America, with the exception of the northern part, which is inhabited by the Esquimaux.

The more northern the part they inhabit, the brighter is the red colour of their skin, though exceptions occur in this as well as in other varieties. Frezier (*Relation du Voyage de la Mer du Sud aux côtes du Chili, etc.* Amst. 1717, 8vo, T. 1. p. 121.) informs us that the people of Chili have white complexions, with a tinge of red on their cheeks, and considers this to be on account of the (rape of) European mothers, which is not improbable. Ge. Ign. Molina (*Saggio sulla storia naturale del Chili.* Ed. 2. Bologna, 1810, 4to, p. 273.) mentions mountaineers with yellow hair and blue eyes; and Felix de Azara (*Voyages dans l'Amérique méridionale,* T. 2. Paris, 1809, 8vo, p. 76.) remarks of the inhabitants of Guayana, that their hair is clear, and that some of them have blue eyes.

Rem. 2. The skulls of the North Americans which are represented in Blumenbach's *Decades*, have little or nothing in them peculiar; but more particularly that of an Aturian, plate 46.; plates 47, 48, Brazilians, and plate 58, a Botocudan. The skulls of the Caribs (partly indeed disfigured by pressure during childhood) are represented in Plates 10, 20.; and also in Lawrence's *Lectures on Physiology*, Plates 10, 11.; and likewise one by Hanauld in the *Mém. de l'Acad. des sc.* and in the *Bibliothèque de Planque*, T. 3. p. 646. Tab. 72. Fig. 1.

The drawings of the Oneidas, which were exhibited a few years ago at Comte's Theatre in Paris (on one sheet), is not bad, but the whole head cannot be seen, which is also the case in the North American savages represented in Blumenbach's *Abbild. Nat. Gegenst.* Tab. 2. A Seminole, in Will. Bartram (*Travels through North and South Carolina.* Plate 6.) is a good representation.

The drawings of the Indians of Mechoacan in Humboldt (*Vue des Cordillères et Monumens des peuples d'Amérique.* Paris, 1810, fol. tab.

52, 53.) are certainly not worthy of being called portraits. The figures in *The Present State of Peru*, Lond. 1805, 4to, Tab. 5, 6, 9, 13, 15, 17, 18, 20, appear to be for the most part too much beautified and embellished. The Prince Max. von Neuwied (*Reise nach Brasilien*. 1. B. Frankf. a. M. 1820, 4to,) has drawings of some savage tribes of the Puris, Plate 2, 3.; Patachos, Plate 7.; Botocndans, Plate 10, 11, and S. 319.; but perhaps in these little attention was paid to the figure of the head. The inhabitants of Finland, figured in Sidney Parkinson's *Journal of a Voyage to the South sea* (Lond. 1773, 4to, Tab. 1.), appear to be real portraits.

The anatomical museum contains the skulls of two wild Brazilians, of the Puri race, which I shall treat in detail elsewhere. They are a pair of very old skulls, so that the teeth are fallen out, and the alveoli closed up; they still, however, retain most of the sutures. These circumstances are also frequently observed in the aged of our own country.

Independent of these, however, the skulls differ from all others which I know of, and seem to be intermediate between the European and Mongolian. The glabella is broad, and the cheek-bones are particularly so, but the latter are not so strong as in the Calmuck; and that part of the superior maxillary-bone which contains the teeth, is not so broad. In neither skull, therefore, do the front teeth of the upper jaw project, but remain behind. If this narrowness of the superior maxilla, were invariably attendant on the remarkable breadth of the cheek-bone, their character would then be easily decided.

64.

The question, whether a race of men anterior to those now inhabiting the earth, has been annihilated with those animals of an earlier creation, which are now extinct, appears to merit a denial. All the petrified or disinhumed human bones which have as yet been found, are of the present construction. Petrifications of monkeys have never yet been observed; but a creature something resembling the *Brody-poda* (*Megatherium*), appears to be the fossil of the highest mammiferous animal yet discovered.

Rem. 1. J. J. Dauxion Lavayasse (*Voyages aux Isles de Trinidad, de Tobago, &c.* Paris, 1813, 8vo, T. 1. p. 62.) caused the chalk bank to be dug up, which at full tide is covered by the sea, and which in the year 1804, General Ernouf had permitted to be dug at the entreaty of the natural historian Gérard, when a whole skeleton was found petrified; Lavayasse likewise found heads and other parts in the same state, and remarks, that all these *Anthropolithoi* lie in the direction from west to east; he likewise found with them weapons and armour, which the savages still use, and therefore believes that this has formerly been the burial-place of these people.

C. König (*On a fossil human skeleton from Guadaloupe, Philos. Transact.* 1814, p. 107—120. Tab. 3.) has described and given a drawing of a similar petrified skeleton without the head, which had been brought to England. That it is a human skeleton there is no doubt; but as the head is wanting, we can say nothing more particular concerning it, particularly, whether they had been Caribs, the form of whose skulls is easily distinguished.

Rem. 2. The Baron v. Schlotheim has, in a late work (*Die Petrefactenkunde auf ihrem jetzigen Standpunkte.* Gotha, 1820, 8vo, S. XLIII—LXI.), described the human bones found in the cliffs of gypseous earth at Köstritz, among the remains of elephants, rhinoceroses, &c. which I have also seen (in the harvest of 1820,) in his valuable collection of petrifications: a frontal bone, superior jaw bones, with well preserved teeth, parts of the pelvis, of the arm and thigh bones. They are not petrified, and of the usual form. Oken pointed out to me, in Jena, the skeleton of an old Polar inhabitant, which is in his museum; shewed me, on the external trochanter, a strong lateral protuberance, one similar to which, he found in a piece of a thigh bone, sent him by Schotien of Köstritz, so that he considers the fossils of the human bones of Köstritz as the remains of an earlier creation. Schlotheim also considers it very probable that they are the remains of an earlier creation, and supports himself particularly by this circumstance, viz. that human bones are so frequently found with the fossils of animals.

On the 9th of March, 1821, the Baron von Schlotheim communicated to me the following interesting information: “I have lately received the

bones of another rhinoceros, together with fragments of human bones, which were discovered together in the loam cliffs of Köstritz. The rhinoceros's bones consist of the right and left hinder thigh, and numerous fragments of ribs and vertebræ. Among the human bones there is a distinct, and pretty long piece of a humerus. As this (*the Friedmannsche*) gyps-clift is a lately re-opened one of the kind, I, on this account, lay more value on the discovery. The small bones of land animals, and fragments of stags-antlers, present here in the same way as in the other gypseous-clifts."

BOOK II.

OF GENERAL ANTHROPOTOMY.

65.

THE organisation of the human body as a whole, and of the individual parts which are employed in its construction, is a study which has never been altogether neglected by Anatomists and Physiologists ; thus, in the writings of Vesalius and Fallopius, we already find much interesting information on this subject, and still more in the later writings of Haller and Soemmerring. Bichat, however, has gained the merit of having subjected to multiplied experiments those parts of the system which, on anatomical or physiological grounds, appeared to be primary tissues, and of having by this means become the author of a new doctrine.

Lectiones Gabrielis Fallopii, de partibus similaribus h. c. ed. Volch. Coiter. Norimb. 1575, fol.

Anatomie générale par Xav. Bichat. Paris, 1801. 2 Voll. 8vo.

Vinc. Malacarne, *I sistemi e la reciproca influenza loro indagati*. Padova, 1803, 4to.

K. A. Rudolphi, *Pr. de c. h. partibus similaribus*. Gryph. 1809, 4to.

Ge. Prochaska, *Bemerkungen über den Organismus des menschl.*

Körpers und über die denselben betreffenden arteriösen und venösen Haargefäße. Wien, 1810, 8vo.

St. J. Bugayski, diss. de partium c. h. solidarum similarium aberrationibus. Berol. 1813, 4to.

J. Fr. Meckel's Handbuch der menschl. Anatomie. 1. B. Allgemeine Anatomie. Halle, 1815, 8vo.

Paolo Mascagni, Prodromo della Grande Anatomia. Seconda Opera postuma. Firenze, 1819, fol. tabb.

C. Mayer, Ueber Histologie. Bonn. 1819, 8vo.

66.

The animal body is composed of solid and fluid parts, the latter of which, however, preponderate; this appears, not only from the circumstance of the former being for the most part formed from the latter, but also from their being every where surrounded by them, even in the most minute interstices.

Rem. Numerous animals, for example, many Medusæ, are so soft and delicate that they very easily dissolve; the same may also be observed of many parasitic growths, viz. the Byssus subterranea.—The circumstance of a fluid being converted into a solid form, may be most distinctly seen, as respects individual parts, in the crystalline lens.

67.

The basis of the solid parts of the animal body is a soft, and of itself, shapeless substance, but which is capable of adapting itself to any form whatever. In animals of the most simple or homogeneous structure, this is the only substance present; in the higher animals, on the contrary, more and more systems of organs exhibit themselves, until we arrive at man, who possesses the most complicated organisation of all.

Rem. 1. This soft fundamental substance of the animal body, (mucous or cellular substance) is essentially different from the rigid

membrane, which constitutes the base of vegetables, or their cellular web, as it is very properly denominated. See K. A. Rudolphi's *Anatomie der Pflanzen*. Berlin, 1807, 8vo, S. 25.

Rem. 2. The shapeless substance of Autenrieth (*Physiol.* I. S. 6.), or the gelatinous substance of Prochaska (*Physiol.* S. 19.), does not appear at all to differ from the mucous or cellular substance, for I know of none else, which is common to all structures. This idea of the above-mentioned authors, has most probably arisen from their having considered the mucous substance, when without form, as being different from that which had taken on any particular form.

Rem. 3. Many parts of the system, and indeed the whole body, have been considered by many authors as consisting solely of vessels; this idea, however, has been already most completely subverted by Albinus. It is therefore very astonishing to find Mascagni, in his *Prodromo*, describing nearly every thing as consisting of aggregated absorbent vessels, and not a single word respecting mucous or cellular substance.

CHAPTER I.

OF SIMPLE SOLID PARTS.

68.

The simple solid parts, or *tissues*, of the human body, are, the *Cellular, Horny, Cartilaginous, Osseous, Tendinous, Vascular, Muscular, and Nervous*.

Rem. 1. It must be observed that *partes similes* is not at all synonymous with *partes simplices*, the latter of which is here the subject of enquiry. To the former class belong those parts which are found in the body in various positions, viz. vessels, whether they be simple or compound.

Rem. 2. Bichat enumerates twenty-two systems, but his classification appears to be more physiological than anatomical, and is likewise not altogether correct; they are: 1. The Cellular system or tissue; 2. Nervous, of animal life; 3. Nervous, of organic life; 4. Arterial; 5. Venous; 6. Vascular, of the hair; 7. Exhalant; 8. Absorbent; 9. Osseous; 10. Medullary; 11. Cartilaginous; 12. Fibrous (*tendino fibrous*); 13. Fibro-cartilaginous; 14. Muscular, of animal life; 15. Muscular, of organic life; 16. Mucous; 17. Serous; 18. Synovial; 19. Glandular; 20. Dermoid; 21. Epidermoid; 22. Hairy.

Rem. 3. Malacarne has made a very peculiar distribution, some parts of which are very excellent, although as a whole it is quite inapplicable. He has a *Systema commune*, that of the skin; four *Systemata generalia*, viz. the cellular, vascular, muscular, and nervous systems; seven *Syst. universalia*, viz. of the membranes, glands, ligaments, bones, intestines (*parenchymatosum*), medulla, and cartilage; seven *Syst. partialia*, viz. of the head, neck, arms, chest, abdomen, organs of generation, and inferior extremities. Each of these is again subdivided; thus, for example, we have the *Systema cephalicum*, in which the eye is situated, which is subdivided into three, viz. the *Systema opticum*, *oculomusculare*, and *lachrymale*, &c.

69.

The *cellular* or *mucous* substance, *cellular* or *mucous* tissue (*tela cellulosa*, *mucosa*, *contextus cellulosus*,) serves two different purposes in the construction of the system: in the first place it unites all the solids with one another, and in the second, it forms the base of every part or organ.

Rem. Hence the justness of the old remark, that if we could separate all the other substances of the body from the cellular tissue, it would still retain its original form, and that of all the organs.

70.

In the first condition under which it presents in the human body, it is found as an investing or conjoining cellular membrane, and in this state it is most easily detected. In the living

body it appears as a delicate, semifluid, formless, ductile substance ; after death, and particularly when preserved from the action of air or water, it runs together, and forms an irregular, floccular web of fibres and laminae, which were formerly considered as the base of the system, and as the primary constituents of cellular membrane ; but as it is not cellular, I would much rather, with Bordeu, give it the denomination of mucous membrane, had it not been that, by the word mucus was formerly understood something altogether different from this (116, 151.) ; the expression would therefore be ambiguous, while the generally accepted term of cellular membrane can be confounded with no other.

Rem. 1. Dav. Cph. Schobinger, Diss. de telæ cellulosæ in fabrica c. h. dignitate. Gott. 1748, 4to. Th. Bordeu, Recherches sur le tissu muqueux. Ed. nov. Paris, 1790, 8vo. Particularly ; Casp. F. Wolf, De tela quam dicunt cellulosa obss. in N. Act. Petrop. T. VI. p. 259. Tab. 6. T. VII. p. 278. Tab. 6. T. VIII. p. 269. Tab. 6. The plates however are not satisfactory. Bichat follows the old method of representing them.

Rem. 2. That which we consider as cellular membrane after death, is not this alone, but it is cellular membrane, containing numerous vessels, particularly absorbents, which are quite invisible.

Rem. 3. Blumenbach (de gen. hum. var. nat. p. 46.) asserts on the authority of Ziun, that the cellular membrane in man is much more delicate and ductile than that of any other mammiferous animal. The idea of the greater delicacy of human cellular membrane, has been already maintained by Haller, Elem. Physiol. T. VIII. P. 2. p. 96. I consider it unnecessary to mention in this place the skin and adipose membrane lying under it, as it appears to vary much on account of many peculiarities, as, for example, the cutaneous muscles, which require a looser membrane ; I was formerly, however, of a contrary opinion. The delicacy of the cellular membrane is, in general, regulated according to the size, the age, and, particularly, according to the parts of the animal body under consideration. See 74. *Rem. 2.*

In the second condition under which it exists in the body, as concealed, parenchymatous, or organic-cellular membrane, it can only be detected by artificial means, either—by a short maceration in water, as in the softer membranes and vessels, glands and intestines; or by a long continued maceration, as in tendons and cartilages; or lastly, by previously subjecting them to the action of acids, as in bones.

Rem. Like Hunter and Hatchett, I have never been able to detect any cellular membrane in the enamel of the teeth; the contrary, however, is asserted by others. In the enamel of the *Cypræa* likewise, according to the latter author, there is little or none contained. In the horny tissue it is either wanting, or is so peculiarly modified, that it appears to be wanting.

The investing cellular membrane of the whole body forms an uninterrupted continuation, and communicates in every part with itself, making various tracts (*tractus*), according to the particular form of the organ into whose structure it passes, where the transition is easier and freer; on the contrary, it is more confined in the greater part of the *linea alba*.

Rem. It is by the knowledge of this general communication of the cellular membrane, that we are enabled to explain the progress of air, water, pus, needles, balls, &c. through different parts of the body; and again, by the strong attachment of the skin to the *linea alba*, one-sided swellings are explained.

Gallandat, *Mémoire sur la méthode singulière de guerir plusieurs malades par l'Emphysème*. In Rozier's *Journal de Phys.* XIV. p. 229. To this subject belong, in particular, the experiments instituted on animals by Bordeu and Fouquet. The latter work, which extols the Hippocratic hypotheses rather too much, has appeared under the name

of J. Abadie : Diss. de corpore cribroso Hippocratis seu de textu mucoso Bordevii. Monspel. 1774, 4to.

73.

The investing cellular membrane sometimes passes into the concealed; this is most evidently seen in vessels; it also takes place in many membranes, as in most of the serous membranes; and on the other hand, the concealed cellular membrane is here and there completely detached, viz. in the lungs, in the nerves, &c.

Rem. Thus a morbid growth often extends only over a small part; as for example, an abscess in the lungs. In the thyroid gland of a hyena I found the acini filled with water, but in such a manner that they might be emptied individually.

74.

The concealed cellular membrane forms a great variety of connexions among the various organs; the investing cellular membrane is every where lubricated with an aqueous vapour, and in many situations contains fat.

Rem. 1. This lubricating aqueous vapour, as also the fat and its secretion, will be discussed in another place. I will here merely remark of the latter, that it may appear in any part of the body during a state of disease, in the healthy state of which it never presents itself.

Rem. 2. In the tropical regions of Asia and Africa, the *Filaria medinensis* is frequently generated in the human cellular membrane. In Europe, the *Cysticercus cellulosæ* presents in the same structure, and scarcely a winter passes but I find some bodies containing them, which are exactly of the same species as those which present themselves in monkeys and pigs. Renner, of Jena, has lately detected a new, but allied, species in the roe.

75.

The cellular membrane, which is the least developed of all simple solid parts, is at the same time the most easily repro-

duced ; it frequently fills up the space formed by the loss of other parts which are not reproducible, and often increases in a superabundant quantity.

Rem. The parts which generally present themselves in cellular membrane (vide 70. *Rem.* 2.) do not exist in these cases in so great a proportion.

76.

The *Horny tissue* (*tela cornea*) is divisible into laminae or fibres ; on the divided surface it is equal and smooth, and in thin places transparent ; it is hard, elastic, and, as its rank in the scale of organisation is so low, containing neither vessels nor nerves, and forming one of the worst conductors of caloric, it thus becomes useful in retaining the animal heat, and is, on this account, well adapted as a covering for the protection of more highly organised parts.

Rem. Like the lamellæ of the selenite, the horny substance, when separated into scales, is transparent and white ; but when many of them are laid on one another, they produce different colours. That which is external to the body varies very much, and is often coloured, as the black epidermis of the Negro and many other mammalia (the horse, the ox, &c.) ; Guinea Fowls (*Gallus lanatus* and *Gallus Morio*), &c. That which is situated internally is always white, but the grey horny substance in the back of the *Loligo*, is an exception ; see the following section, *Rem.* 1.

77.

The horny tissue is the substance which forms the external covering of the body (*Epidermis*), together with the nails and hair, also the internal membrane of the intestines (*Epithelium*), and perhaps also that of the air passage, of the urinary and generative organs, and of the vessels ; indeed all serous membranes appear to be extremely analagous to it (113.).

Rem. 1. The internal membrane of the intestinal canal here and there evidently developes itself as a horny substance, which contributes much

in support of this opinion; this happens most evidently in the stomach of fowls which feed on grain, and in the two first stomachs of the Ruminantia, where the epithelium is evidently horny. I have observed the same laminated structure in the intestines of a Badger (*Anat. Physiolog. Abh.* S. 46.), which so frequently happens in the epidermis, and Rom. Hedwig (*Isenflamm's und Rosenmüller's Beitr.* II. S. 54.) has observed the same thing in mangy dogs. In Guinea Fowls, where the epidermis is black, the peritoneum (as is the case in many fishes) is likewise dark coloured, but scarcely any conclusion can be drawn from this, for in these the periosteum is likewise black, as are all the fibrous membranes and ligaments.

On the subject of these interesting animals, which I have lately, through the kindness of Alex. v. Humboldt, had an opportunity of dissecting, see C. J. Temminck, *Histoire naturelle des Pigeons et des Gallinacés.* Amst. 8vo, 1813, T. 2. p. 253, 256.—P. S. Pallas, *Zoographie Rosso-Asiatica*, T. 2. Petrop. 1811, 4to, p. 90.—Chapotin, *Topographie médicale de l'isle de France*, p. 31.

Rem. 2. In those animals which belong to the class of Mammalia, the horny substance presents itself in an enormous excess; in many the epidermis is extremely thick; in others the growth of the hair is strong, or growing in spikes or clots (manis); to these belong the horns situated on the bony spigots; the beards of whales; in many animals the large hoofs; in the horse the disease denominated *Castanea*.

78.

The horny substance is, even on account of its homogeneousness, so widely extended, that there is no animal in existence in whose structure it is not present, but in the smaller animals it is naturally of a delicacy proportionate to their size. It presents itself early in the embryo; it reproduces itself quickly and easily; it often takes on a morbid growth, and many parts of the animal body present a horny aspect when dry.

Rem. It is merely necessary to take a glance over the animal kingdom, and we will perceive that it exists in all, at least as an external

covering. The more imperfect condition of a part frequently deceives us; thus Cuvier has taken the shells of the aplysia, which actually contain carbonate of lime, for horn, (which John has analyzed at my request.)

79.

The *cartilaginous tissue* (*tela cartilaginea*) presents itself merely as cartilage (*cartilago*, *chondros*); it is of a bluish white colour, transparent, very elastic, and, next to bone, it is the hardest of all the solids. Cartilage, in the divided surface, exhibits a variety of appearances; some are smooth and uniform, and are called simple cartilages; others are more or less fibrous, the fibro-cartilages as they are called (*Chondrosyndesmos Falop.*). The cartilages of the ribs are of a medium texture to these two.

Rem. The fibro-cartilage consists of simple cartilage, and an addition of tendinous fibre. The simple cartilage appears to consist of a peculiar combination of cellular membrane with gelatine (or with the substance which is produced by boiling it). After macerating the cartilages of the ribs for a considerable time, a remarkable leafy web presents itself. Fr. Dav. Hérissant, Sur la structure des côtes de l'homme et du cheval. Mém. de l'Ac. des sc. de Paris, 1748, p. 241.

80.

Simple cartilage is a substance which answers two distinct purposes in the animal body; thus, there are some (*cartilaginee temporariae seu ossiscentes*) which are used for a certain time to supply the place of bone, these become ossified, and sooner or later cease to be cartilage; others are permanent, and do not ossify (*c. permanentes*).

81.

All bones have, at an earlier period, been in the state of cartilage. The permanent cartilages are destined partly to

cover, as a border, the articulating surfaces of bones, partly to form the more firm foundation of various organs, as the ear, the nose, the eyelids, larynx, trachea, &c.

Rem. 1. The rings of the trachea, the cartilages of the larynx, generally become ossified in old age, but in a very imperfect and irregular manner.

Rem. 2. Ossifying cartilages are found in nearly all vertebral animals without exception; in the crustacea, insecta, mollusca, and in some of the radiata. Permanent cartilages present themselves in many of the annelides (viz. the leech), and even in some intestinal worms.

82.

Fibrous cartilages are found principally in such bones as perform no motion on one another, for example, between the body of the occipital bone, its cuneiform process, and the temporal bone, and between the ilium and sacrum; or where, together with a limited degree of motion, a strong attachment is necessary, as between the vertebræ; or they assist in enlarging the cavities of joints, and in affording them a certain degree of elasticity; or lastly, as a point of support to many tendons.

Rem. For this same purpose we see them widely extended through the animal kingdom. It is by this substance likewise that the shells of muscles are bound together.

83.

Though the structure of cartilage appears to be so simple, and presents itself so frequently in preternatural growths, it is very singular that, as far as experience has gone, it is never reproduced.

Rem. 1. Cartilages are preternaturally formed in all descriptions of parts, for example, in serous membranes, and in those cavities which are lined by them. I have found pieces of cartilage, of a considerable size, in those large sacks which children frequently bring with them into the

world, and which are attached to the inferior part of the vertebral column, as likewise small pieces of bone between hydatids, and various kinds of soft masses.

Rem. 2. Those places from which cartilages have been taken away, are generally filled up by cellular membrane, and sometimes they are not at all replaced. After wounds of the articular cartilages, ancylosis or caries takes place. But here, there is a badly complicated injury; through the loss of the perichondrium, the conditions necessary to reproduction are either rendered extremely difficult, or are altogether suspended. The gaps of bones also, are not closed under such circumstances, for example, after the use of the trephine. This non-reproduction of cartilage, does not appear to arise from the cartilages themselves, but from other circumstances connected with them. Thus broken bones are so much the more easily united together, the nearer they approach to the state of cartilage.

84.

The osseous tissue (tela ossea) forms the substance of bones (*ossa*). These are the hardest of all animal substances, of a yellowish white colour, smooth externally, but their internal structure varies. The broad or flat bones consist of two tables, between which is situated a cancellous substance; the long bones are hollow internally, containing marrow; their parieties are firm and dense, but the ends are cancellous or spongy; the round and mixed bones have a thin smooth edge externally, but internally the whole substance is cancellous.

Rem. 1. This internal difference necessarily causes a variety in the distribution of the marrow. In the round and mixed bones throughout, in the diploë of the broad bones, and in the extremities of long bones, the marrow lies in small sacks or vesicles of the retiform web; the marrow of the middle portion of long bones lies in larger sacks; in the walls of the same, as is likewise the case in the edges of all bones generally, the marrow is contained as oil, without having any particular reservoirs or

sacks. In the bones of high soaring and quick running birds, the latter only is observed to exist, and the cavities and extremities of their long bones, the diploë of the broad bones, and the retiform web of the round and mixed bones, contain no marrow, instead of which they are filled with air. In cold-blooded vertebral animals, the medullary apparatus is quite wanting, there is, however, in many, viz. the osseous fishes, a considerable quantity of oil contained in the bony substance.

Rem. 2. The bones of the *Esox Belone* are always green, and will remain so for many years, when excluded from the air; in the *Blennius viviparus* they take on their colour by boiling, of which circumstance I have convinced myself; this likewise takes place in the *Ammodytes Tobianus* and *Labrus Lapina*, according to A. Risso, *Ichthyologie de Nice*. Paris, 1810, 8vo, p. 263. The bones of the *Labrus æruginosus* are the greenest; and this also is the case without boiling: Pallas, *Zoogr. Asiat.* Ross. T. III. p. 266. In Guinea Fowls it is the periosteum only, and not the bones, which is of a black colour, 77. *Rem. 1.*

85.

All bones, whatever may be their particular appearance, are, by the separation of the earth they contain, reducible to cartilage, and may at length by maceration be reduced to cellular membrane. They have all likewise been formerly in a state of cartilage.

Rem. 1. This is evident from the remarkable osseous covering of the Tatous, and I find that the bones of the heart in the deer, the fallow deer, &c. and also in young individuals, are cartilaginous. Preternatural formations of bone are likewise produced in the same manner, and thus we perceive in those parts which are frequently found ossified, viz. the arteries, serous membranes (the surface of the spleen, &c.), at one time cartilaginous, and at another bony substances. Thus the production of stone is easily distinguishable from ossification, for there is no cartilage in the constitution of stone or earthy concretions.

Rem. 2. The formation of the bones has been the most accurately described by Ant. Scarpa (*De penitioni ossium structura*. Lips. 1799,

fol.), and illustrated with excellent copper plates. Mich. Troja (*Osservazioni ed Esperimenti sulle ossa*. Napoli, 1814, 4to, tabb.), and Mich. Medici (*Esperienze intorno alla tissitura organica delle ossa*: in the *Opuscoli scientifici* Bologna, 1818, 4to, p. 93—107. tab. IV.) have in vain attempted to bring forward, as an objection to this, the lamellated structure of bone, for their method of investigation, viz. that of exposing the bones to the action of air and fire, after being partially subjected to the action of acids, is by no means to be approved of. The merit of the work on the Investigations of bones, in the healthy and diseased state, by J. Howship (in the *Medico-Chirurgical Transactions*, Vol. VI—X. London, 1815—19, with plates), appears to me to be very limited; the solar-microscope was here quite superfluous; and the compounded microscope, as Howship treated the bones, is not sufficiently particularized, to enable us to form a conclusion on the subject; and his canals, cells, &c. are nothing more than the spikes and plates of Gagliardi.

Rem. 3. The spine of the Sepia (*Cuttle Fish*) which Tilesius (Isenflamm's und Rosenmüller's Beiträge, 1. S. 91—136. Taf. 3.) has accurately described and represented in plates, is very singular, and with respect to the manner in which it is produced, somewhat obscure.

86.

The *enamel* (*substantia vitrea*) is a substance which is peculiar to the teeth, in which there is no cartilage, and in this respect it differs from all other bones.

Rem. The great connexion of the enamel with the nature of the tooth, appears from this circumstance, that the teeth of men, and of all such animals as are provided with them, are never found destitute of it, even when they are found in diseased enlargements, as for example, in enlargements of the ovary. In the teeth of animals in which they are joined together, another peculiar substance presents itself, which is denominated cementum.

The osseous, like the cartilaginous tissue, is destitute of nerves, and the small quantity of them which are found in it, are destined for the purpose of supplying the vessels of the medullary membrane. The numerous vessels, with which it is supplied at an earlier period, are gradually decreasing, and its former plentiful supply of nutriment and easy reproduction, vanish in the same proportion.

Rem. This observation only relates to certain parts of the bones. Many entertain a very erroneous opinion, viz. that a reproduction always takes place in Necrosis, and that the whole bone is formed afresh, and they found their opinion on this, that the old bone is generally not totally dead, but in a diseased state. Leveillé's opinion is much better founded; *Mémoires de Physiologie et de Chirurgie*. Paris, 1804, 8vo, N. IV.

In man, all the bones are united together to form a whole (skeleton), except the lingual bone, and some sesamoid bones. Many parts ossify in old age or in disease.

Rem. In many of the mammalia the number of sesamoid bones is increased, so that not only the flexor muscles, but also the extensors, are supplied with them; instead of costal cartilages, many of them have bones placed in the same way as birds, viz. the Vampyr, Opossum, the Ant-eater; in many the penis-bone is added to this, which occupies the middle portion like medullary cells; in many herbivorous animals there are heart-bones; in the Tatous a singular osseous covering like armour. The tendons of the muscles in birds, especially the gallinaceous tribe, but more particularly in the crane, are found to be in a state of ossification at a very early period. A great increase in the bony mass takes place in the tortoise, and on the shield-plate of many fishes. Bones are also found in the stomach of the crustacea, &c. Shells of testaceous animals. The stalks of numerous Zoophytes.

The *tendinous fibre* (*fibra tendinea*) is of a dense and firm structure, white, and of a shining silver-like appearance. It sometimes forms compact bundles of very various forms, sometimes cutaneous expansions: the former are partly connected with the muscles as tendons, partly destined to the formation of ligaments of various kinds; the latter constitute, by their less developed fibres, the coverings of the cartilages and bones, and are called perichondrium, periosteum, or by their stronger fibres they form the dura mater of the brain, the aponeuroses.

Rem. The tendinous membranes of the latter kind, and the tendons of muscles, possess more of the glistening appearance of silver. The ligaments fall more into the yellow appearance, more particularly those ligaments which are, on this account, denominated the *ligamenta flavicantia*. The dark coloured tendinous membranes of the Guinea Fowl have already been taken notice of, 77. *Rem.* 1., and the same black colour is found on the external covering of the abdominal medulla in the leech.—As varieties of this we may mention skinny tendons, particularly that of the *musculus plantaris*.

Tendinous fibre appears to consist in a great measure of condensed cellular membrane, but there is either some peculiar substance superadded, or the cellular membrane is changed in a way unknown to us; which is shewn by its silver-like glance, its very slow maceration in cold water, and its amber-like appearance when dried. Those ligaments which arise from contracted vessels (80.) either invariably, as those formed from the ductus arteriosus, umbilical vein and artery, or occasionally, differ very materially from the above, and appear to consist of nothing more than cellular membrane, like the doublings of the serous membranes, which have been denominated false ligaments.

Rem. We must not be understood as referring to the parts lying within these doublings. When tendinous fibres and cartilage are combined, then the compound is said to be tendino-cartilaginous, 79.

91.

The fibrous membranes, viz. the periosteum and the dura mater, are sometimes extremely vascular; these vessels, however, are not altogether for their own proper nutriment; the tendinous membranes of the extremities, the tendons of muscles, and all ligaments, are very sparingly supplied with them. When they are provided with nerves, these are destined solely to the supply of their vessels. The restoration of these parts is very imperfect in warm-blooded animals, notwithstanding the homogeneousness of their texture, and the easy re-union of lesions of the same.

92.

It was formerly believed, that the bulk of tendon was proportionably greater to that of muscle in the fœtus, than was the case at later periods, but this only arose from the redness of their appearance on account of their greater degree of vascularity; the periosteum, on the contrary, is actually of greater extent in them, as it has to encompass all the epiphyses of the bones.

Rem. This is very interesting in the brute, whose metacarpal or metatarsal bones consist, in the ruminantia, of two, or in the pig, of four bones, lying close on one another, each of which is surrounded by periosteum, so that when the former are dissolved, the latter must be absorbed, however deeply it may penetrate between them.

93.

Tendinous fibres present in all vertebral animals, but in very various proportions; thus all the larger mammalia

possess a much greater proportion of tendons and ligaments than the human subject; that of the amphibia and fish is much smaller. In the invertebral animals there is very little tendinous substance to be found; in more homogeneous animals it is altogether wanting.

Rem. A great inequality is observed in this respect among the amphibia; thus tortoises possess very little tendon, frogs, on the contrary, much more. The very quick ossification of the tendons in many birds, (88. *Rem.*) is very deserving of attention. Cuvier (*Leçons d'Anat. comp.* 1. p. 134.) relates the same thing of the springing mammalia. I have never observed it in any of these, even in the *Dipus*, which he particularly mentions on this subject. In crustacea and insects, the hard tendons scarcely merit such a denomination.

94.

The *vascular fibre* (*fibra vasorum*) exists chiefly as *arterial fibre* (*fibra arterialis*), which constitutes the middle coat of the artery; it is white, flat, hard, and brittle, and differs in this respect completely from the muscular fibre. During life, it exhibits no oscillatory movements; by chemical investigation, it appears to consist of different constituents, and when boiled, it imparts a different taste, vide 150. *Rem.* 1. 172.

Rem. 1. The *venous fibre* (*fibra venosa*) is so delicate, and exists in so scanty a proportion, that little or nothing can be said with certainty respecting it, vide 110.

Rem. 2. The ends of lacerated muscular fibres appear soft and almost fluid; arterial fibres, when torn, exhibit hard and unequal edges.—To these distinctions we might further add, that the arteries of most animals are completely similar, while muscle on the contrary infinitely varies in different animals.

As it is now ascertained beyond a doubt that the arteries, even in warm-blooded animals, are reproduced, we have thence an evidence of the simplicity of their structure, and of the difference between the arterial and muscular fibres, which in warm-blooded animals, are never generated in foreign parts, and are never reproduced.

Rem. Arteries are not, however, produced in the proportion admitted by Parry and others, but those which they consider to be new vessels, are nothing but enlarged vessels carrying more blood than formerly, by which they appear to be newly produced, as I shall shew in the special physiology. In false membranes, however, and in all kinds of tumours, they are undeniably new formations, and in this an evident similarity is observed between the arterial and uterine fibres, which last appear and vanish again, and on this account cannot be considered as muscular.

The *muscular fibre* (*fibra muscularis*) is of a red colour, roundish, soft, and of a very fine texture; while contracting during life, they exhibit a trembling, oscillatory motion, which is peculiar to themselves.

Rem. 1. The red colour is peculiar to the muscular fibres of vertebral animals merely, and even in the amphibia they appear very pale, and still paler in a great number of fishes, although the flesh of a few of them is very red, as the pelamides. This alone proves that it does not depend on the colour of the blood, but this is shewn more particularly by the circumstance, that the flesh of red-blooded worms is white, as, for example, that of the earth-worm.

Rem. 2. The remote fibres of the muscles appear to me to be quite solid. Meckel (Handb. d. Anat. 1. S. 477. § 316.) has adopted the same opinion; although they appear to him to be slightly flattened. Link, a very powerful adversary in investigations of this kind, and also others, have considered them as hollow; they were formerly thought to

consist of vesicles, but we will speak more of this when considering the theories of muscular motion. Mascagni (Prodrómo, p. 97.) describes them, as consisting of small cylinders, filled with a glutinous matter (*sostanza glutinosa*). He particularly extols the merit of a caustic alkali in treating them (p. 109.), and quotes particularly on this subject, Tab. XII. Fig. 9, 27. of his work, which appear to me to say very little on the subject. I think that the muscles should be investigated as fresh as possible, and when their fibres become the subject of enquiry, they should be sometimes unaltered, and at others exposed to hot water.

Rem. 3. Muscles during life contract by the action of a stimulus; they are not easily lacerated, although examples of this do now and then occur, viz. in the heart, of which I have twice seen a laceration in the posterior ventricle. After death, there is very little force required to tear a muscle asunder, as has certainly been the case in the example described by Kelch (Beiträge zur Patholog. Anatomie. Berlin, 1813, 8vo, S. 43.), which he considered as having happened during life.

97.

The classification of muscles into those of animal and of organic life, presents sufficient difficulties even as respects their physiology, but its application to anatomy is altogether impracticable.

Rem. 1. If we consider as muscles of animal life, those merely which are concerned in loco-motion, we completely set aside all anatomical distinction, for many of the muscles of the organs of respiration and the alimentary canal are of an exactly similar construction with the former. Whether we consider this distinction or classification of the muscles in respect to volition or not, it still remains physiologically inadmissible, for there are many muscles which may be subservient to our will, but then they are generally capable of action independant of it. Then we may ask, To which of these belong the muscles of the bladder?

Rem. 2. The loco-motive, and similarly constructed muscles of the reproductive system, consist of smaller or larger fibrous-bundles (*lacerti*), which are more or less separated from one another by means of cellular membrane; they are further provided with tendons, particularly at their extremities, but frequently also in their middle, or edges; sometimes they are interwoven by them, or they are distinctly divided by them into parts. The remaining muscles of the reproductive system constitute canals or reservoirs, frequently in such a manner, that their fibres appear to run in opposite directions; they less frequently decussate each other. These muscles are frequently paler and destitute of tendon, but the contrary is found to be the case in the heart; this last is likewise very red in many fishes, where the muscles of loco-motion exhibit a very slight degree of redness.

98.

The muscles are provided with a very numerous supply of vessels and nerves; in warm-blooded animals they are never reproduced; they are likewise never found in morbid tumours, or in any other part of the body, than those in which muscles are invariably found (in the muscular sheath, as it is called).

99.

The muscular system is very extensively diffused through the animal kingdom, but this is liable to very considerable variations. In the larvæ of insects and in worms (according to the Linnean acceptance), we find, under the skin, scarcely any thing more than muscular sheaths, the fibres of which are generally but loosely joined together; they are less frequently interwoven; and, for the most part, very white.

Rem. Among intestinal worms, the *Echinorhynchus* is the only species in which (on the proboscis) we find any muscles which can be compared to those of loco-motion. The muscles on the tail of the craw-fish

appear at first to be very singular, but they may with propriety be compared to many of the muscles which are situated on the vertebral column of the higher animals; and the many thousand muscles found in the proboscis of the elephant (Cuvier, Leçons, T. V. p. 289.), exhibit a very striking analogy to the cutaneous muscles of insects. The flesh of the Kalmar is in every thing, even in the taste, very similar to that of many fishes, and Oken has been much too keen in his distinctions, when he denies the existence of muscular substance or flesh in invertebral animals. In these they are certainly not so much developed as in the vertebral animals in their mature condition, but they are, in the embryo of the latter, still more imperfect than in them.

100.

The *nervous fibres* (*fibræ nerveæ*) are of a very fine texture, very pliable, and of a white colour. In the nerves they are surrounded by delicate and very vascular coats (*Neurilema*), by which they are connected into smaller, and these again into larger bundles (*fasciculi*), which are finally enveloped in a firm sheath; all the former coats are very loose, so that, by means of their rugæ, the unextended nerves acquire a subdivided or spiral appearance, which however disappears by extension. The fibres of the brain are not tubular, and may very easily be detected in many places; in others they appear as if dissolved, so that they cannot be represented in every part of the brain; this however is more particularly the case in the spinal marrow, and many of the ganglia of nerves.

Rem. 1. The nervous substance is evidently the most delicate of the whole system. The most solid part of them is but delicate, and consequently every strong concussion of them is dangerous, as is the case with the brooding egg, according to the interesting experiments of Erman. (It has lately been denied that eggs are at all injured by concussion, with respect to their capability of being hatched; but as far as I have been able to learn from enquiry, I have found that pheasant-eggs,

when intended to be hatched, are never sent by vehicles, but are carried by men.)

Rem. 2. In the embryo the fibrous texture of the brain is not developed, and in hydrocephalus internus there is no appearance of this structure in the distended parts, in which, according to Gall, the fibres are conspicuous. I have convinced myself of the above fact by the investigation of two hydrocephalic subjects, the latter of which (a newly born infant) contained, in the ventricles of its brain, three pounds of water. By a morbid hardening of the brain, however, the fibrous texture of many parts, particularly at the centrum ovale, is very conspicuous, which I have frequently found the case in epileptics, and in the bodies of thirty persons who had died of true Typhus.

Rem. 3. The canals or fibres which Gebb. Ge. Theod. Keuffel (Diss. de Medulla spinali. Hal. 1810, 8vo.) has, after Villars, mentioned as existing in the spinal marrow, as likewise the membranous substance of other authors (Barba, see the following section,), I consider to be nothing more than blood vessels.

101.

The nervous substance appears, from microscopic investigation, to consist of small irregular bodies, which are generally described as small globules, but to me they appear much too soft, and not sufficiently distinct, to be described by so determinate a form.

Rem. Della Torre, who has viewed many things in an improper light, considered the globules of the different parts of the brain and nerves as differing in size from one another. Ant. Barba (Osservazioni microscopiche sul cervello e sue parti adjacenti. Napoli, 1807, 8vo.), who had formerly made his investigations in company with Della Torre, denies this from his later observations.

102.

The *medullary substance* of the brain and spinal marrow, of the ganglia of nerves, and also of the substance of particu-

lar nerves, viz. the superior part of the sympathetic and of the olfactory nerves, is connected with a peculiar substance of a softer consistence, and which chiefly, but by no means entirely, consists of blood vessels.

Rem. We find in the grey or cineritious substance of the brain, the same irregular mass as in the white part, so that Barba has not distinguished between the globules of the two substances. In most parts of the brain the grey lies in direct contact with the white substance; and in other parts, particularly in the cerebellum, they are separated by the interposition of a yellowish intermediate substance, which, however, possesses more of the character of the cineritious substance. In the crura of the brain the cineritious substance has a blackish appearance.

103.

The nerves have, like the muscles, been divided into those of *animal* and of *organic* life. But this classification can in no respect be followed, at least in an anatomical sense. For their connexion with ganglia, the greater softness of their texture, and their redder aspect, are not such infallible marks of organic life as has occasionally been asserted, as the sympathetic nerves have been too much insulated.

104.

The *centralization* of the nerves takes place in the brain and spinal marrow, where they frequently unite with the cineritious substance, but this cannot be every where ascertained. The *peripheric* extremity of some of the nerves of sense are quite evident, but they appear every where to be formed alike, viz. shut up in themselves. We never find a nerve to be lost in a vessel, in a gland, or appear to vanish among the fibres of a muscle, still less to unite to it by a free extremity. The nerves appear every where to entwine the vessels, and they surround, in the same way, the larger or smaller fibrous bundles of the muscles, around each of which

they form a loop. Something similar exists in the electric organs of fishes. The nerves are also adequate to this, as their peripheric extremities are considerably larger, as was first demonstrated by Soemmerring.

Rem. I consider this point, at which I have arrived by investigations, as of great importance. Reil (*Exerc. de structura nervorum*) believed that the nerves finished their courses by free extremities, which is certainly never the case, for if such were the fact, it must have shewn itself. Prochaska (*Physiologie*, p. 82.) believes that the nervous substance is blended with the other constituent in the organ, viz. the albumen; but this also does not appear to be the fact, for the nervous substance remains completely distinct. Sam. Ch. Lucaë (*Quædam obss. anat. circa nervos arterias adeuntes*, Francof. ad M. 1810, 4to,) considers that large nerves pass into arteries, as in the art. brachialis, represented in the figure; but the figure owes its existence to a hasty preparation, and is completely false; what he says respecting it in § 6. is equally as little founded on nature.

To convince ourselves of the manner in which the nerves surround the muscular bundles, it is only necessary to prepare the tongue of a large animal, viz. that of a horse; but to follow the links of the nerves of the tongue and lingual muscles, is by no means the work of a day. Those who complain of having nothing more to do in human anatomy, would never be able to represent the nerves of every part of the body, were they to apply their whole lifetime to the task, and still this must be done; our present knowledge of the nerves afford us merely a superficial view of the system, and even in this respect it is not complete: vide 194.

105.

The nervous substance in warm-blooded animals does certainly appear to reproduce itself, but then the fibrous texture is not distinct. Nerves never appear to be present in after-productions or morbid tumours; we cannot, however, determine whether their vessels are destitute of nerves or not.

Rem. In the reproduced limbs of large water-salamanders, which I have kept alive from a year and a half to two years, I have never been able, even by the assistance of a magnifying glass, to distinguish the point at which the new nerves were given off from the old ones.

106.

All vertebral animals, crustacea, insecta, and mollusca, are supplied with nerves ; they are also proved beyond a doubt to exist in the radiata, and of the entozoa, in the *Strongylus Gigas*.

Rem. They have been considered to exist also in other intestinal worms, vide *Entozoorum Synopsis*. Berol. 1819, 8vo, p. 574. Sensibility is also exhibited by the more homogeneous animals, but no nervous substance can be observed in them.

CHAPTER II.

OF COMPOUNDED PARTS.

107.

All the organs of the human body are composed of the more simple parts, or constituents, as they are denominated, into which they may, by analysis, be reduced.

Rem. When we say that the organs are composed of such and such simple textures, we merely mean to imply, that such simples have been detected in their composition, and by no means to signify that these textures came together by degrees, and that, by their perfect and gradual combinations, the organs were constructed.

Among the compound parts, the vessels and membranes are the most simple; these however, differ again from one another.

Rem. When vessels are considered in respect to their great extent and easy production, they must be considered as next to the mucous substance, particularly in respect to the nerves, as *partes similes* (68. *Rem.* 1.); but when we consider them in relation to their distinctions and composition, they must then be comprehended under the present section.

Vessels are either of a common or a proper kind. To the former class belong the arteries (*arteriæ*), veins (*phlebes*, *venæ*), absorbent vessels (*vasa absorbentia*); to the latter, the canals proper to secreting organs, as the biliary vessels, the salivary vessels, the ureters and urethra, the tubulæ seminiferæ, &c.

Rem. The secreting or exhalant vessels, and the vessels of the hair, are also classed with the general vessels, and the latter have been used to explain many circumstances both by physiologists and pathologists; but they require no mention in this place, as all that is necessary to be said respecting these hypotheses will be found in the special physiology (under the doctrine of the circulation of the blood, secretion).

All vessels consist of at least two coats, and the blood vessels of three; all of the latter kind, and likewise many of the proper vessels, are provided with smaller or nutritious vessels, which are denominated *vasa vasorum*; many of them are known to be supplied with nerves; to the absorbent vessels of warm-blooded animals there is a peculiar glandular or gangli-form apparatus attached.

Rem. The older writers, and among those of a later date, Fr. Aug. Walter (*Angiologisches Handbuch*. Berlin, 1789, 8vo.), considered the veins as possessing only one coat and the arteries two; both of these opinions, however, are false; for however fine the texture of a vein or absorbent vessel may be, it is impossible that they could consist of one coat, and be provided with valves internally. Mascagni (*Prodromo*, p. 61, 64.), like the older anatomists who preceded him, describes the arteries and veins as both consisting of four coats, but his external one (*ascitizia*) is the cellular membrane which connects the vessels to the adjoining parts, and can by no means be called a coat. On the fibres of the veins see the work of Henr. Marx, *Diatrise de structura atque vita venarum*. Carlsruh. 1819, 8vo, tab. Besides the longitudinal fibres, he describes the veins as possessing transverse or circular fibres also; these I consider to be nothing more than cellular membrane. I have never seen distinct circular fibres in the veins of the human subject, nor even one in the vena cava of the horse. Even the longitudinal fibres are so weak that they scarcely admit of a comparison with those of the arteries, as already mentioned in 94. Mascagni and Meckel likewise deny the existence of transverse or circular fibres in the veins. Beruh. Nath. Gottlob Schreger (*Fragmenta anatomica et physiologica*. Fasc. 1. Lips. 1791, 4to, Tab. p. 9.) contends that the great thoracic duct of the human subject and the calf, are provided with circular fibres, and Mascagni denies that the absorbents have any fibres at all, and even Meckel is of the same opinion with regard to the thoracic duct, while Soemmerring contends for the contrary. I myself can find none either in the human subject or in the horse.

111.

The *general* or *common* vessels are very extensively supplied to the body, but not all to the same extent. The absorbents only present distinctly in the Vertebrata. The blood vessels are observed to exist in the Crustacea, Arachnida, Mollusca, and in many worms. Instead of these the proper insects are provided with a peculiar system of common vessels, carrying air, or the trachæa. The proper ves-

sels are much more generally supplied, and something of the kind has even been found to exist in many Infusoria, as for example, in the *Vibrio*.

Rem. 1. Mascagni remarked also, that invertebral animals were provided with absorbent vessels. Among the proper vessels there are none whose use has occasioned so much variety of opinion, as the gall-ducts of insects, as they are denominated; thus some authors have considered them as serving the purpose of urinary vessels, while others, on the contrary, contend that they are absorbents.

Rem. 2. As the sides of the vessels are frequently so extremely delicate that they become indistinct, we have thence an easy explanation of the error into which many authors have fallen, in considering the blood, when placed under the microscope, as having a ramified appearance, similar to that of vessels; the blood has actually been contained in the vessels themselves, which, from their great delicacy, have escaped their observation.

112.

The membranes (*tunicæ, membranæ*) have, like the vessels, been divided into two orders, which are accordingly distinguished as *general* or *proper* membranes. To the former class belong, the serous, the mucous, and the fibrous membranes, the cutis vera, and the epidermis. As belonging to the latter or proper class, we may enumerate many of the coats of the eye, of the brain, of the ovum, &c.

Rem. 1. The classification of the membranes is a subject which was formerly too little attended to, but which has, of later years, gone to an opposite extreme; and however great the reputation of Bichat, as a general anatomist, may be (of which science he first laid the foundation, in his work entitled, *Traité des Membranes*. Paris, 1799, 8vo.), he has, notwithstanding, been the means of propagating not a few erroneous opinions.

Rem. 2. The older authors, therefore, from the little attention they paid to this subject, imagined that a great many membranes were continuous with one another, which are now considered as contiguous (*contiguæ*, not *continuæ*), and this, according to the latest experiments, is certainly more correct.—Andr. Bonn, *Specimen de continuationibus membranarum*. L. B. 1763, 4to.—Wrisberg, *Comm. de membranarum ac involucrorum c. h. continuationibus partim dubiis partim veris*, in his *Comm.* p. 343.—Malacarne, *i sistemi*, &c. (68. *Rem. 3.*).

113.

All the *serous membranes* (*tunicæ serosæ*) are found to exist in the body as the lining membranes of the internal parts or cavities, they are also entirely destitute of nerves and vessels; they are smooth and free, on at least one side, through which an aqueous vapour (*serum*) penetrates, by which they appear to be lubricated.

Rem. 1. The distribution of these in the body is likewise very various; sometimes they constitute shut sacks or cavities, as for example, the abdominal and thoracic cavities, the pericardium, the arachnoid membrane of the brain, vaginal membranes, bursæ mucosæ, and the synovial membranes; others constitute the internal membrane of all vessels, whether of the general or proper class, of the œsophagus, trachea, the urinary and genital passages; the conjunctiva, according to its expansion and position, is a kind of intermediate membrane between the serous membrane and the cuticle.

Rem. 2. Sprengel in his *Pathologie* (1. B. § 222. 2. B. § 539.), speaks of nerves being pointed out to him in the pleura by Meckel the father; in his *Institut. Physiol.* 1. p. 448. he says; *nervus nullus fere*, &c. but nerves nowhere exist in serous membranes.

Rem. 3. Many have denied in them the existence of blood vessels, but have admitted that of colourless, or of absorbent and secreting vessels, or of the latter only; but all of these are equally false. Not a single vessel any where enters their substance, but they lie over vessels when

these exist in other organs, viz. in the heart, the liver, &c.; for if the serous membranes contained vessels, they would then form doublings, as the mesentery, the omentum, the folds of the intestines. The serous membranes, may, with great ease, be separated from the absorbents and the other vessels of the organs which they cover, particularly during a dropsical state of the organ (as of the pericardium), and there is not a single trace of a vessel to be found in them, even by the assistance of the microscope; they consist simply of cellular membrane, and are the extremities of this, expanded in free cavities.

Rem. 4. No serous membrane therefore performs any part in secretion, but the fluid merely passes through them in the same way, as the perspiration through the skin, without their requiring any particular pores for this purpose. In general also, they afford to all internal parts that which the epidermis affords to the cutis vera,—they supply a covering to them,—they afford them a boundary, and a medium. Particular purposes are likewise effected by some of them, viz. the bursæ mucosæ, which afford great facility of motion to the tendons, as the bursa may be distended; the idea of them supplying the tendons with a lubricating fluid cannot be admitted, vide 71.

Rem. 5. Inflammations and other disorders which are ascribed to the serous membranes, are in like manner ascribable to the parts to which they are attached, and if either their structure or function be altered, these membranes are first affected, viz. thickened, ossified, &c. A serous membrane is equally as little capable of taking on inflammation as the epidermis; and as the various morbid matters which penetrate through the cutis, are not the product of the epidermis, neither is this the case internally with the serous membranes. Thus pleuritis, pericarditis, and peritonitis are inflammations of the surfaces of the lungs, of the heart, the contents of the abdomen. The profuse flow of mucus from the eye in Egyptian ophthalmia, has in like manner been ascribed to the conjunctiva, and in order to explain this circumstance the more easily, they have described the conjunctiva as a mucous membrane, which is evidently not the fact.

The *mucous membranes* (*tunicæ mucosæ*), which have likewise been distinguished into the proper membranes (*t. propriæ*), or vascular (*t. vasculosæ*), or nervous (*t. nerveæ*, viz. *nervous tunics*, which term has originated from the older acceptance of the word nervous), have no free sides, but lie between other membranes, and always appear to be provided with vessels and nerves, generally also, with mucous glands (*glandulæ muciparæ*).

Rem. 1. These membranes bear the same relation to the cutis, which the serous membranes do to the cuticle. In many parts of them the mucous glands are very large, as in the cavity of the mouth, the œsophagus, the gut; in other parts they are more difficult to detect, as in the nose.

Rem. 2. These membranes have sometimes been considered as consisting of different layers, and thus they have been divided into different coats, viz. a vascular and a (mucous) glandular coat; but this cannot be admitted; the glands may be deeper or more superficially situated, but they always lie in the vascular coat; this may be thicker or thinner, but in the same body it is always uniform throughout.

Rem. 3. The most common error of later times, is that of considering the mucous coat as the internal membrane, viz. in the intestinal canal, in the urinary bladder, &c.; this however, is no where the case, as it is always provided with a (serous) covering (*Epithelium*) on the internal or free side of the part to which it belongs, which is frequently very fine, as in the air passages, in the stomach, &c. The error arises chiefly from this circumstance,—the internal covering takes on a very varied appearance, thus for instance, it appears to vanish at the pyloric orifice of the stomach, or its appearance here is different to that which it has in the stomach itself. Thus also the villous coat is by some improperly considered as a mucous membrane.

Rem. 4. The proper tunics of vessels, which are entirely absent in those of the mucous glands, (and also in the vessels of some passages, as for example, in those of the ureters) may be considered as belonging

to this class of membranes, they do not however lie between two membranes, but between cellular tissue and another membrane or tunic.

115.

The *fibrous membranes* (*tunicæ fibrosæ, aponeuroticæ*) are mentioned here merely on account of their connexion; all that is necessary to be observed concerning them, has already been mentioned, 89, 91.

116.

The *cutis vera* (*corium, cutis*) is the membrane which lies immediately beneath the epidermis; it constitutes a covering which extends over the whole body; it is more compact externally, and looser internally; it is plentifully supplied with vessels and nerves, and is in various parts supplied with sebaceous glands (*glandulæ sebaceæ*).

Rem. 1. It is sometimes extremely thin, as on the face; in other situations, however, it is much thicker, as on the back and soles of the feet, in which last, its external compact, and internal looser surfaces appear to differ, as the former is coloured in the Negro, and in diseases of the skin collections of fluid take place between it and the epidermis; or when the old epidermis has died and peeled off, a new one may be easily reproduced; thus—it has been asserted that a peculiar membrane (*rete*) or mucus (*mucus Malpighii*) exists between the cutis and epidermis, or they have, besides the cutis and epidermis, made a great number of subdivisions, all of which are artificial. When the cuticle is macerated in water, it is separated into laminæ and mucus, but beneath the fresh and natural epidermis, no mucus can be found to exist, neither is there any appearance of a second epidermis or Rete Malpighii, as is found on the tongues of large animals, as the ox. The Exanthemata have their seat rather in the external part of the skin, but this is easily transformed into the other.

W. Cruikshank (on invisible perspiration) describes a number of layers

in the skin, and represents them in figures, but it is the skin of a Negro which he represents, and besides this, we must take into consideration the favourite object he had in view, which was, to demonstrate the existence of pores in the skin. He enumerates them as follows; 1. The cuticle; 2. The external layer of the mucous membrane; 3. The proper mucous membrane; 4. The membrane in which the layers are situated; 5. A very thin membrane; 6. The proper cutis.

G. A. Gautier (*Recherches sur l'organisation de la peau de l'homme et sur les causes de sa coloration*. Paris, 1809, 8vo. *Recherches anatomiques sur le système cutané de l'homme*, ib. 1811, 4to,) has the following divisions: First, The skin; Secondly, The rete mucosum, which he divides as follows: 1. Bourgeons sanguins; 2. Couche albide profonde; 3. Gemmules; 4. Couche albide superficielle; and, Thirdly, the epidermis. But he has unhappily selected the sole of the foot of the Negro, for the subject of his superficial investigations. The figure is of no value.

Dutrochet (*Observation sur la structure de la peau*, *Journ. Complém. T. V. cah. 4to*, p. 366.), has also unnecessarily divided the skin into six layers.

Rem. 2. The sebaceous glands, (*glandulæ sebaceæ*) which appear in various parts of the skin of man and many other animals, appear in certain parts to have something marked, as on the nose, the eye-lids, and the auditory passages; still however, they are not sufficient to characterize, in any way, the internal skin, as it is doubtful whether they exist at all in most parts, at least they cannot be detected in them. In this respect likewise, every thing appears to depend on the medium in which the animals exist: thus, for instance, the skin of the fish is provided with mucus, which in many appears in great quantities; the *Gastrobranchus*, perhaps, exhibits the greatest proportion of it, and frequently a very complicated apparatus, as for instance, in the Shark and *Torpedo*; likewise in the skin of all worms (in the Linnean sense) which exist in the water. The function of our skin likewise frequently changes when it is not exposed to the air, but remains in direct excitement with another cutaneous surface: vide Hébréard (*Mém. de la soc. d'émulation*, T. 8. p. 153.), *Sur l'analogie qui existe entre les systèmes muqueux et dermoïde*.

Rem. 3. The tendinous fibres, which, in the sole of the foot, pass

from the aponeurosis into the skin, can with as little propriety be considered as belonging to the skin, as the muscular fibres of the face, which, for the purpose of effecting its motions, are so plentifully supplied to it. Thus the greatest analogy exists between the mucous membrane and cutis vera, which were formerly considered as identical.

117.

The *Epidermis* constitutes the external covering of the whole body, to which purpose it is peculiarly adapted, on account of its homogeneous texture and easy reproduction, by its want of sensibility and non-vascularity: vide 77, 113.

118.

The *glands* and *viscera* are the only parts of a solid and compound structure which yet remain to be discussed. They are so variously constructed that it is extremely difficult to characterize them; we must, therefore, either consider them in respect to their distribution, by which they are more easily distinguished, or to their construction, and then there are but few glands which can be considered as such; the remainder must be viewed as viscera.

Rem. We consequently find the greatest variety of opinions among authors, to convince ourselves of which, it is only necessary to compare Bichat with the older and later anatomists.

119.

The sebaceous, mucous, and salivary glands, likewise those for the secretion of the milk (*mammæ*), coincide in this respect, viz. that they consist of solid acini, which secrete

the fluids from which they have received their names, which fluids are carried off by peculiar passages (*ductus*).

Rem. These acini are sometimes globular, sometimes roundish, but compressed; they always consist of cellular tissue peculiarly interwoven, which are perforated by vessels, and through which nerves are, at least, seen to pass, if they are not actually distributed to their structure. The sebaceous glands of the human body, with the exception of the Meibomian glands, are simple (*glandulæ simplices, cryptæ sebiferæ*); compound glands are frequently supplied to the anus of animals, but they are only compound on account of their opening into one canal, and thus constituting a common duct. The mucous glands which exist in the lips, palate, tongue, also on most parts of the intestinal canal, &c. are simple (*cryptæ, folliculi mucosi*); heaped together or aggregate (*aggregatæ*); but where each acinus evacuates its contents distinct from the rest, the sum of them are called Peyerian glands. The salivary and lacteal glands are much more compound than the former, and are denominated conglomeratæ, in which the delicate ducts of the individual bodies unite, and constitute one or more principal ducts.

120.

But if we leave these acini out of the question, which may otherwise be considered as peculiar glandular substances, and only consider them in respect to their capability of preparing peculiar fluids, which are carried off by distinct ducts, —then the liver, the kidneys, and testes, would likewise demand the appellation of glands.

Rem. 1. This arrangement appears to me to be more preferable, as we are otherwise too much bound down. In the prostata, the acini are so closely connected together that it is impossible to separate them; this is more particularly the case in the liver; the kidneys are likewise composed of distinct bodies, but these are very few in proportion to the whole mass, and seem to depend principally on its vessels (in animals this is still more or entirely the case); in the human testicles there are no acini, but merely vessels. The testicles of fishes, on the contrary, are con-

structed like glands, and their abdominal salivary glands alone exhibit such a variety of forms, and pass finally so completely into ducts, that it is quite impossible to lay down any rule for their form, but each body must be considered as a distinct gland, whether it be composed of cells (*the prostata*), of cavities (as *cryptæ simplices et compositæ*), of vessels (as the *testes*, the *liver*, and a number of the *conglomerate glands* in animals), or of solid acini,—as long as it appears to be a distinct part of the body, which prepares and evacuates a fluid peculiar to itself.

Rem. 2. The appendages of the absorbent system in higher animals, which were denominated conglobate glands (*glandulæ conglobatæ*), can in no respect be admitted as such, as they are merely knots of the absorbents; we might with as much, if not with more propriety, consider the ganglia of the nerves as glands. Chaussier denominates the former the ganglia of the absorbent vessels.

121.

By *viscera* or *splanchna*, we signify those compound organs of our body, which present themselves either singly or in pairs, and which do not prepare or secrete any peculiar fluid.

Rem. This distinction is partly negative, but it cannot be properly done otherwise to be accurate. In this way also, we avoid the impropriety of classing the thyroid, thymus, the spleen, and kidneys, with the glands, which can be more conveniently enumerated with the viscera. In our body no viscus presents, naturally, more than double; in other animals it is otherwise, as, for instance, in the whale there are many spleens, three hearts in the sepia, many eyes in insects, &c.

122.

The different parts of the body, collectively, constitute a whole; but the connexion of the different parts of each individual system with one another, or with certain central

organs, is much more intimate than with the other systems of the general organism, and thus systems, more or less isolated, are constructed, which exhibit a structure and sphere of action peculiar to themselves.

Rem. 1. In the higher animals we find various central organs, and each of these exerting a powerful and distinct influence over those parts which belong to it. In these we also find the reciprocal influence of all central organs and systems on one another, to be very great. In the simpler animals, on the contrary, all the systems are more independent of each other; and in the simplest animals there are no central organs at all.

Rem. 2. In foetal monstrosities this dependence of the organs on each other is very beautifully exhibited. In a child, where the eye and orbit was wanting, I found the optic nerve of the same side likewise absent in the brain, and the thalamus nervi optici of the side formed a projection, and returned with a rounded continuance back on the brain; vide *Abh. d. K. Ak. d. Wiss. in Berlin*, B. 1818, 4to, S. 185.

123.

Besides the connexion of the organs to certain systems, as above mentioned, there is a second, which arises from the position of the same in different parts, into which the body is divided, according to its form, viz. the head, the neck, the chest, the extremities, &c.

Rem. In some diseases we find the parts belonging to one system particularly affected. This may be very general, so that, for example, all the bones, the periosteum of the whole body, &c. suffer; or it is limited to certain parts of a system, viz. to particular nerves, as in the tic douloureux, sciatica, to the vessels of certain organs, &c. On the contrary, we find in other diseases, that parts which belong to the most opposite systems suffer together, viz. in gangrene, cancer, &c. In the latter, the common constituent of all organs seems to be affected, and in the former case, that alone which is proper to an individual tissue. Thus, for

example, in Psoas abscess, the nerve may remain a long time uninjured.

124.

In the human body, the greatest degree of symmetry is in general observed to predominate, so that if a line be drawn through its middle (the *linea mediana*, as it is called), it will divide most of the single organs into equal parts, and separate most of the double ones laterally, at equal distances from each other.

Fried. Henr. Loschge, De symmetria h. c. inprimis sceleti. Sect. 1. et 2. Erlang. 1793, 8vo.—Franz Moritz Heiland, Darstellung des Verhältnisses zwischen der rechten und linken Hälfte des m. K. und ihrer Verschiedenheiten im gesunden Zustande. Nürnberg. 1807, 8vo.—F. L. H. Ardiu, Considérations sur la ligne médiane. Strasb. 1812, 4to.—M. S. du Pui, de affectionibus morborum hominis dextri et sinistri. Amst. et Lips. 1780, 8vo.—J. Bapt. Monteggia, Fasciculi pathologici. Turici, 1793, 8vo, p. 1—31. Morbi symmetrici et asymmetrici.—C. Fr. Ed. Mehlis, comm. de morbis hominis dextri et sinistri. Gott. 1818, 4to.

125.

The symmetry of the external parts is particularly correct; and internally, that of the bones and their appendages, the ligaments, &c.; of the brain and spinal marrow, likewise the animal muscles and nerves, the organs of the senses; of the organs of voice, of the breasts, and organs of generation; and of most of the vessels supplied to all these parts. The organs of respiration and of the secretion of urine, are tolerably symmetrical. Those parts which are destitute of symmetry are, the heart, and the greatest part of the digestive

organs, and with these the vessels and nerves which are supplied to them.

Rem. Where the symmetry of the body is more or less suspended, the organs are always so distributed, that an organ which is only found on one side is opposed to another existing only in the opposite side; thus the liver lies on the right side, the spleen and broad end of the stomach on the left. The commencement and extremity of the small intestines are quite symmetrical with the adjoining parts, as is likewise a part of the colon. The intestinal canal, when taken from its situation, may be divided into two equal parts.

126.

The symmetry does not exist in relation to the importance of the parts, and only appears to be indispensable where an equilibrium is required for the body in the regular arrangement of its general or individual movements.

Rem. 1. This position is most decidedly confirmed in the Pleuronectes, whose heads are completely unsymmetrical. In many animals of the lower class (crustacea, insecta, annulata, &c.), we find the whole intestinal canal, and even the liver, or the vessels which correspond to it, to be quite symmetrical. The numerous hearts of the sepia, or the single heart of the crustacea and arachnida, and the dorsal vessels of insects, are likewise symmetrical. The parts of generation of many worms are not, on the contrary, symmetrical. In those worms also, where the intestinal canal and nerves are absent, the symmetry (contrary to the opinion of Heiland) is exact. Bichat (*sur la vie et la mort*) evidently attaches too much importance to this circumstance.

Rem. 2. Besides the lateral symmetry, as it is generally called, another has been mentioned, viz. between the anterior and posterior parts of the body; likewise one between the superior and inferior parts: both of these, however, are confined to too few points to admit of any discussion in this place.

The right side of the human body, on the whole, generally predominates over the left; yet there are many exceptions to this rule, and a transposition of the parts which belong to the chest or abdomen may, without injury to the whole, take place from the right to the left side.

Rem. 1. It can in no way be shewn that any one part exists in the male sex in any other respect to the same side, than in the female.

Rem. 2. A great deal of the preponderance of the right side over the left is attributable to exercise and habit. If a child were taught by its nurse to use the left arm in preference, it would gain more freedom in the exercise of this arm, and the left side would presently acquire the superiority. It is probably from resting on one side during sleep, that the greater width of the large vessel of the same side arises. On the curvature of the spine towards the right side, vide Bull. Soc. Philom. 1817, p. 13.

Rem. 3. Sometimes the contents of the thorax and abdomen are found to be reversely situated, and sometimes the heart only. About two years ago, I found in the body of a child, which died immediately after birth, the heart situated in the natural way; but the aorta, both at the arch and descending portion within the thorax, lay on the right side, and towards the diaphragm it passed completely over to the left side, and continued its course through the same in the usual manner; the greatly elongated ductus arteriosus (*Botalli*) sunk into the left subclavian artery. A figure of this case may be found in Otto Bernhard, Diss. de arteriarum e corde prodeuntium aberrationibus. Berol. 1818, 4to.

Rem. 4. The little importance of the position of parts, may be seen from the crossing of the optic nerves of fishes, where at one time the right, at another the left, nerve passes over its fellow.

When any part of the body is double, they are both developed and come into action at the same time.

Rem. Nothing is more erroneous than the hypothesis of Gall, viz. that, of double organs, while one is in action the other is at rest. We see, without the least doubt, with both eyes, hear with both ears, at the same time; milk is secreted by both breasts, the urine by both kidneys, &c. Double organs suffer both at the same time, or after one another, as for example, the eyes; the corresponding teeth on opposite sides become at the same time carious, &c. Some affections indeed do not pass beyond the median line, and thus we observe hemiplegia in its various degrees.

129.

All the organs of the body undergo certain degrees of developement, of which not only the size, the form, and the distribution are different, but also the texture itself.

Rem. 1. We find, in like manner, certain degrees of developement among animals, and which indeed does not happen regularly according to their higher or lower rank in the system,—insects, worms.

Rem. 2. Man undergoes degrees of developement similar to those of the animals which approximate nearest to him in the scale of creation, but it is not true, as many have asserted, that he passes regularly through the various classes of animals before he arrives at perfection. He is a human embryo, distinct from all other animals and animal embryos; he never was a worm, &c.

Rem. 3. A plurality is particularly observed in those parts, during the developement of which no obstacle ought to be in the way of that of other parts with which it is connected: thus the parts of the cranium are individually developed about the brain; the occipital bone and vertebral column about the spinal marrow; thus the bony tentorium of animals is composed of a number of small bones.

130.

In all the parts of the system a great uniformity of texture is ~~obs~~erved to prevail, and in very many also with respect to their form, size, number, and position; others again vary

more or less in this respect, but generally without any inconvenience, as the more important parts are also the more invariable.

Rem. 1. From varieties in this respect, we must except those changes which are effected by disease, and which are often improperly distinguished. Thus, for example, some authors speak of the absence of the gall-bladder; but in those cases which have come under my observation, the traces of its destruction were evidently perceptible, consequently, it was no variety; we likewise hear of the round ligament of the hip joint being absent; but this has happened in no other way than by preceding caries, by which it has been destroyed. We must, in the second place, except those changes which arise with increasing old age, and where we are often at a loss, how much to ascribe to senility, how much to those morbid conditions which have existed during the person's lifetime. To this cause we may attribute the ossification of many parts, the sand found in the pineal gland, the colour of the lungs, of the bronchial glands, &c.

Rem. 2. All kinds of varieties may be brought under two heads, of which the first comprehends all those which arise from congenital formation, which ought to undergo a change, but which has remained and developed itself according to its earlier condition. If this prove injurious in any respect to the person, it is denominated disease or mal-conformation, viz. the double hare-lip, the continuance of the membrane of the aqueous humour of the eye, or the pupilar membrane, as it is called; if no bad effects are observed to result from it, then it is denominated a variety, as a permanent division of the kidneys, the frontal bone when remaining in two distinct parts. The second class comprehends all varieties properly so called, which do not owe their origin to any earlier condition, but to a peculiarity in the reproductive power. Thus, for example, instead of the musculus obturatorius internus being, as is usual, embraced above and below by a musculus geminus, the superior geminus is wanting, and the inferior is doubled in size. Thus it frequently happens, that the median and musculo-cutaneous nerves unite, and in various ways; and when such a state of things exists, then nervous twigs are given off from the one which would otherwise arise from the other.

Rem. 3. Varieties in bones refer merely to their size and strength, by which the whole skeleton, or the proportion of its individual parts, is determined; or they are changes produced by the nervous, vascular, or muscular system, viz. various depressions in the cranium, in the vertebral column, &c. The bones are all alike in every important point. The ligaments are liable to variations almost solely in respect to size. In muscles we frequently find supernumeraries, which facilitate certain movements, viz. of the hand and foot; muscles are sometimes wanting, but they are generally only small tensors of the fasciæ or of the tendinous membranes (psoas minor, pyramidalis, palmaris longus, plantaris); the more essential muscles are never wanting, not even the larger tensor of the fascia of the thigh (*tensor fasciæ latæ*). The vascular system exhibits great and numerous varieties, even in important parts, viz. the vessels of the heart, the vessels of the lungs, the liver, &c. but by far the greatest part of these varieties are unimportant. It is only such trifling varieties that are found in the nerves; thus, for instance, a nerve of sense is always found to originate in the same place, this never varies, and it never takes a different course, &c. The brain is extremely invariable, and the same may be said of the organs of sense, and of most of the viscera; the kidneys, indeed, frequently vary, but generally in no important respect.

Rem. 4. In the animal kingdom, it is probable that the most infinite variety of forms may exist in every organ, and indeed it might be said, that it is by the different combinations and modifications of these that all the different animals are constructed. We ought not therefore to be surprised, when a variety from the natural structure, no matter of what part, presenting in man, happen to agree exactly with the regular structure of the corresponding part in any brute; the contrary would only shew the deficiency of our knowledge of comparative anatomy. The above cases happen, however, without producing any defect in the human powers, and consequently they ought not to be overrated.

BOOK III.

OF GENERAL ANTHROPOCHEMY.

131.

ANTHROPOCHEMY, like the chemistry of organic bodies in general, has unfortunately the following insuperable difficulty to contend with, viz. that every thing which belongs to its dominion looses its organic action either previous to, or while being subjected to chemical experiment; so that we are only able to investigate the lifeless remains of organic matter. We can therefore scarcely hope to attain an accurate knowledge of the chemical actions of organic bodies, or of the elective affinities of their substances, and we will never perhaps be able to discover with what relation to each other all these substances are situated during life, in order to distinguish with certainty, the products from the educts. The chemistry of organic bodies is, notwithstanding, of great importance to us in the study of physiology, because, in the first place, it informs us how the various substances which are detected in the composition of certain parts, agree or differ from each other; and, in the second place, it determines,

with the greatest certainty, that the most, if not all organic changes, are connected with chemical processes, or that they may be considered as such; and our suppositions respecting many of these have already attained no small degree of probability.

Rem. The objection which was formerly made to animal chemistry, viz. that vitality was entirely excluded, is not considered to affect it so much as was formerly supposed. It is now employed to treat the substances under consideration in as many various ways as possible, and not, as formerly, to subject them to individual violent operations, which can lead to no conclusion or result.

Besides the general chemical works of Fourcroy, Thompson, Thénard, Berzelius, and John, the following require to be particularly mentioned:

J. J. Berzelius, *Föreläsningar i Djurkemien*. Stockholm, 1806, 1808, 2 Thle. in 8vo.—*Ueberblick über die Zusammensetzung der thierischen Flüssigkeiten*. Nürnberg. 1814, 8vo.—*Uebersicht der Fortschritte und des gegenwärtigen Zustandes der thierischen Chemie*. das. 1815, 8vo.

J. Fr. John's *Chemische Tabellen des Thierreichs*. Berlin, 1814, fol.

132.

The greatest advances in animal chemistry, are to be expected from the daily increasing intimacy of its connexion with physiology and pathology, and particularly from the comparison of the individual objects of the various orders of animals, and from taking into account at the same time, the age of the individual under consideration.

Rem. The mere chemist is not the person to contribute to the advancement of animal chemistry; it is necessary that he be likewise a physiologist, or that he should, during his investigations, unite his labours most intimately with those of the physiologist. When he knows, for example, how soon the vesicle of the blood of a warm-blooded ani-

mal, when compared with that of a cold-blooded animal, is dissolved, when he knows the various forms and sizes of the same in the different classes of animals, his investigations must of necessity gain by it. Thus, it is by keeping his eye continually on physiology, that Berzelius has contributed in so remarkable a degree, and in so short a time, to the advancement of this science. Ferd. Runge, a late naturalist, has displayed very considerable talent for such investigations in vegetable chemistry:—*Neueste phytochemische Entdeckungen zur Begründung einer wissenschaftlichen Phytochemie*. Berlin, 1820, 8vo.

CHAPTER I.

OF SIMPLE PONDERABLE SUBSTANCES.

133.

Of the ultimate fundamental substances, or elements of the animal body, we know nothing. They are probably not numerous. We are by no means justified in assuming a peculiar animal matter, which does not present itself in other natural bodies.

Rem. 1. The expression *animal matter*, is applied by authors to signify two different things. By some it is used to signify, but improperly, a peculiar elementary matter, and by others to denote the compound animal substances in general.

Rem. 2. Nitrogen is by no means exclusively peculiar to animal matter, although the Ammonia, particularly when in a great quantity, which is disengaged from a substance, may determine it to be of animal origin. The circumstance of Prussic acid being disengaged from ani-

inal parts which have been burnt with an alkali, is just as little a peculiarity of animal matter as the former.

134.

The following are the simple ponderable substances which are at present considered by chemists as existing in animal matter:—*Oxygen, Hydrogen, Nitrogen, Sulphur, Phosphorus, Carbon, Iron, Sodium, Kalium* (Potassium), *Calcium, Talcium*, and the base of *Muratic acid* (Muriaticum).

Rem. 1. The simple imponderable substances, as they are denominated, are mentioned 172. et seq. but not as peculiar substances.

Rem. 2. The ponderable simple bodies are divided into Oxygen and Inflammable bodies; the latter are again subdivided into Metalloids (Hydrogen, Nitrogen, Sulphur, Phosphorus, and Carbon), and Metals (those mentioned above). None of these exist in the human body in a simple state, but only in multiplied combinations.

Rem. 3. Magnesium, which is frequently mentioned by some authors, as a constituent of the human body, is equally as casual as the silicea of others. Fluoric acid might perhaps be enumerated among these, which, in combination with lime, exists in a very trifling degree in the bones, and particularly in the enamel of the teeth.

135.

Oxygen, which cannot be obtained either in a solid or liquid state, but only in the form of gas, is contained in the human body in the most numerous forms of combination, and also in very considerable quantities; it not only forms a constituent of all the fluids, but likewise of all the solid parts of the body; and according to the various proportions of it do the properties of these appear to differ, and hence the difference between albumen and mucus; this difference, however, does not merely exist in relation to their consistence,

but in every other respect. It also forms combinations in numerous parts which are separated from the common fluid, so that these parts, as for instance, the perspiration, the urine, and the respired air, present a free acid. We obtain it partly from the surrounding atmosphere, which, without a certain proportion of it (one-fifth), would be unfit for respiration, and consequently for life, and partly from fluid and solid nutriment of various kinds.

Rem. The air-bladder of some fishes, although in very few cases, is filled with oxygen alone; these excepted, in the collections of gases in cold-blooded animals, and plants which contain oxygen, the proportion of oxygen to that of nitrogen, is seldom greater than in atmospheric air. In warm-blooded animals there is nothing resembling this, for the air-sack in horses is nothing more than the Eustachian tube enlarged in size.—Oxygen is likewise exhaled during the summer from the green parts of vegetables.

136.

Hydrogen, which, like oxygen, can only be represented pure in the form of gas, and which, when in combination with the same, forms water, presents itself in all parts of the human body, whether solid or fluid, under various forms of combination; it is very quickly produced in us from the nutriment, and accumulates under various forms. Part of it is continually separated by the common discharges of the body, and part in a peculiar manner (by the liver).

Rem. The proportion of hydrogen in the different animals and their parts, as likewise in plants, is infinitely various, and is well characterized in flatus. See 138. *Rem.*

137.

Nitrogen, (*Azoticum*), like the preceding (oxygen and hydrogen), can only be obtained in a simple state, in the form

of gas, and is likewise a constituent of most animal parts. Nitrogen exists in the greatest proportion to oxygen in atmospheric air (as 79 to 21), and forms the (of itself unchangeable) conductor of those parts which are separated from the air, and disappear in the lungs, and likewise of the substance which is there combined with it. The nitrogen, which passes into the substance of the body, is received from the food, and the excess passes off, the greatest part by the kidneys.

Rem. Nitrogen exists in a much greater proportion to other gases in animals than in vegetables; still, however, they are by no means destitute of it, and some families of them, as the cruciformia (also the tro-pæolum) and the fungi, contain it even in a greater proportion.

138.

Sulphur is found to exist in the animal body in a very small proportion; it is never free, but combined with soda, potass, &c. and frequently as a constituent of albumen. Sulphuretted hydrogen gas is likewise frequently formed in the intestinal canal.

Rem. 1. In the excellent prize Essay of Seb. Just. Brugmans, whose early death is much to be lamented, we find the sulphuretted hydrogen gas mentioned as the conductor of the contagion of that dangerous distemper (Verhand. van de Maatsch. te Haarlem, B. VII. St. 2. Amst. 1814, 8vo.).

Rem. 2. In plants, likewise, the sulphates are found only in very small quantities.

139.

Phosphorus is found in nearly all parts of the human body, and particularly in the bones; it has never been detected alone, but always in combination with various other substances.

Rem. Phosphorus likewise exists in plants, but it is found in much smaller quantities in them than in animals. The phosphates, in particular,

are very common among the fungi, whose composition in general very much resembles that of animals.

140.

Carbon is contained in many of the fluids, and in all the solids of the animal body; it is continually being produced by most of the vital processes, but when in too great a proportion, it universally acts injuriously, so that, in order to avoid this, it is dissipated in the atmospheric air as it increases, which is very easily effected.

Rem. Carbon exists in a much greater proportion in vegetable bodies, so that when a vegetable is burnt, it still retains its original form by means of the quantity of carbon present.

141.

Iron (Ferrum) is contained in the state of oxide in the ashes of animal parts, particularly in the cruor, to which it peculiarly belongs. It was formerly considered as existing in the blood, combined with phosphoric acid; but Berzelius has shewn this to be erroneous, and that nothing can be mentioned with certainty as to the form in which it is held in it, as none of our re-agents are able to detect it in the blood.

Rem. Froriep (in a note to Cuvier's Compar. Anatomy, P. 1. p. 77.) says, that Hombert has informed him, that the blood of the Sepiæ, and white-blooded animals in general, contains no iron. Erman, on the contrary (Wahrnehmungen über das Blut einiger Mollusken, in den Abhandlung. d. K. Akademie zu Berlin, 1816, 1817, S. 199.), has detected iron, and very probably also manganese, in the blood of the *Helix Pomatia* and *Planorbis corneus*.—Poli (Test. utr. Sicil. T. 1. p. 51.) likewise speaks of iron in the blood of the Mollusca, viz. in the *Arca Glycymeris*, but in such a manner, that we can depend little on the experiment, were this even the fact.

Soda never presents in the animal body in a pure state, but always in combination with other substances in the different fluids ; sometimes combined with albumen without any acid, sometimes with muriatic acid, and at others with the phosphoric acid, or less frequently with the lactic, carbonic, or sulphuric acids ; thus constituting the muriate, phosphate, &c. of soda.

Potassa is found in various animal parts, but is invariably combined with acids, generally as the muriate, less frequently as the sulphate of potass.

Rem. 1. In Berzelius's *Djurkemi*, P. I. p. 15. it is mentioned as presenting under both of these forms in the human urine. In his *Ueberblick*, p. 74. he only mentions the sulphate of potass, as being present in the urine ; but on the contrary, the muriate of potass is mentioned, p. 33. as being found in the serum of human blood, and p. 76. in the milk of the cow.

Rem. 2. Both of those alcalis (142, 143.) are found in vegetables ; the mineral, however, more than is generally believed, and the vegetable so frequently and generally, that it has obtained the name of the vegetable alkali.

Lime (Calx) is a very common constituent of the human body, but is always found in combination with an acid, particularly the phosphoric and carbonic acids, and less frequently with fluoric acid. They form, in combination with other animal substances, the earthy matter of bones ; but the phosphate of lime is also found in many fluids, and in other solids besides the bones ; at least they have, by analysis, been

detected in those parts, if they even have not existed in this state in the fluids during life.

Rem. Lime is the peculiar earth of animal bodies, and even in a great measure the product of the animal organism, in the same way as silica, which is so abundant in vegetables, may be considered as a product peculiar to their organisation.

145.

Magnesia exists in very small quantities, and only when combined with phosphoric acid, the phosphate of lime presenting at the same time, particularly in the bones.

146.

Muriatic acid, in combination with the alcalis, particularly with soda, is contained in almost all animal fluids.

Rem. It belongs to the province of chemistry to explain the later views entertained respecting muriatic acid, viz. its formation from chlorine and hydrogen gas.

CHAPTER II.

OF GENERAL ORGANIC SUBSTANCES.

147.

The simple, or homogeneous substances, as they are denominated, exist in the organic bodies in very complicated, and

frequently very difficultly decomposable, combinations, which circumstance never happens but with them, so that they are properly denominated *organic*.

Rem. Some authors have spoken of inorganic combinations in the human body, but improperly; even the excrements and concretions are of a peculiar kind, and are found to differ from all the substances which belong to the inorganic kingdom; vide 153.

148.

The general organic substances of the human body are as follow: *Gelatine, Albumen, Fibrine, Mucus, Water, Fat, Lactic acid.*

Rem. 1. In animals of the most simple construction and diminutive size, many of these substances exist in very small proportions, but whether one or more of them are altogether wanting is not determined. The most of them are indeed extended through the whole animal kingdom. Many of them exist also in the vegetable kingdom, but in different proportions, according to their peculiar structure, and the preponderance of other simple substances.

Rem. 2. The special organic substances, as the bile, urine, sugar of the milk, will be discussed under Special Physiology.—On the Osma-zome, which by some is enumerated among the organic substances, see 155. *Rem.*

149.

Gelatine (Gelatina) is obtained by boiling the solid (*cutaneous, fibrous, cartilaginous, osseous*) parts in pure water, which, when cooled after evaporation, presents itself as an insipid, inodorous, soft, trembling mass. When dried, it forms a hard, semi-transparent body, with a glass-like fracture, or glue (*Colla*). It easily dissolves in warm water, and when cooled, it again forms a jelly. It is soluble in acids and

alcalis, but neither in alcohol, æther, nor oils; it is precipitated by tannin. It consists of,—

Carbon,	-	-	47.881
Hydrogen,	-	-	7.914
Oxygen,	-	-	27.207
Nitrogen,	-	-	16.998
			<hr/>
			100.000

Rem. 1. Chemists formerly admitted the presence of gelatine in the blood and milk; but according to Berzelius it exists in neither. According to Thenard, it exists in none of the animal fluids. John says, that it is not contained in the horny substance.

Rem. 2. The animal gluten (*Gluten animale*) which is mentioned by many physiologists, particularly by Haller, can by no means be considered as synonymous with gelatine, but is equally as hypothetical as their simple fibres, and can never be shewn as they describe it.

Rem. 3. The vegetable gelatine, as it is denominated, which is obtained from so many various fruits, but particularly the acid fruits, is distinguished from the animal gelatine by the acid it contains, and by its being entirely destitute of nitrogen.

150.

Albumen, which is one of the most abundant constituent parts of our body, appears under two forms, viz. in the fluid and solid states.

The fluid albumen (*Albumen liquidum*) exists in the eggs of birds, in the serum of the blood, in the lymph of absorbent vessels, in the aqueous moisture of all cavities, and of the cellular membrane, and in various proportions to the water; so that by a greater proportion of albumen it acquires more of an adhesive quality, as in the eggs of birds, and (though a little modified) in the synovia of the joints; it is in a less proportion in the other cavities, as in the cavities of the chest and abdomen, the pericardium, the brain, the eye, 153.—It is colourless, transparent, tasteless, inodorous; it is coagulated

by acids, alcohol, æther, metallic solutions, and infusion of galls, so that it precipitates in the form of white flakes. At a high temperature (165° Fah. or nearly 60° Reaum.) it likewise coagulates, and becomes an insoluble mass; after evaporation, it remains as a transparent, yellowish, shining, brittle, amber-like mass, which, still retaining its original peculiarities, is soluble.

The solid or coagulated albumen (*albumen solidum seu coagulatum*), which principally composes the nervous substance, but presents itself in many other parts besides this (somewhat modified), is white, tasteless, elastic, insoluble in water, alcohol, and oils, but very soluble in alcalis.

Albumen is always in combination with soda. It consists of,—

Carbon,	-	-	52.883
Oxygen,	-	-	23.872
Hydrogen,	-	-	7.540
Nitrogen,	-	-	15.705
			<hr/>
			100.000

Rem. 1. The greatest part of the fluid contained in morbid swellings, as enlargements of the ovary and serous membranes, consists of albumen, but in various forms; it may present in the sack as small concretions, and likewise as a hard uniform mass; it may (in soft tumours) form a sort of sticky adhesive water, or a gelatinous mass (in bursæ mucosæ), &c.

Rem. 2. Albumen is found in many vegetable bodies; in the fungi, which on this account become so hard during ebullition, in the juice of the Papaya, Galactodendron, on which Humboldt has collected so much interesting information.

151.

Fibrine (*Fibra sanguinis, materia fibrosa, fibrina, lymphæ plastica*) is contained in the blood and chyle, and forms a great (the most substantial) part of the muscles; so that this substance is of considerable importance in the human body, particularly

as it separates so easily from the blood. The fibrine sometimes appears coagulated, even while the blood is flowing from the artery, particularly during rest, as in the blood contained in the vessel of a living animal, which is tied at both ends ; it easily disengages itself from the blood during inflammation, and thus lays the foundation for new formations. The fibrine easily coagulates after death, whatever be the temperature. It separates from the blood, when the latter is agitated, as a soft stringy substance, which appears at first of a reddish colour, but when poured in cold water, becomes rather whitish ; it is inodorous and insipid ; is insoluble in water, alcohol, and in acids, but in the cold it dissolves in potass or soda, without its properties being visibly changed ; in warm solutions of the above alcalis it is decomposed. Fibrine consists of,—

Carbon,	-	-	53.360
Oxygen,	-	-	19.685
Hydrogen,	-	-	7.021
Nitrogen,	-	-	19.934
			<hr/>
			100.000

Rem. 1. The fibrous coat of the arteries (94, 173.) contains no fibrine, as shewn by Berzelius ; Svenska Läkare Sällskapets Handlingar (Stockh. 1813, 8vo.) lib. i. No. 3. p. 90—96.

Rem. 2. The similarity between fibrine and albumen is very great, and, according to Berzelius, the same effects are produced upon them both, when treated with acids, alcalis, alcohol, æther, and water. On the contrary, the easy coagulation of fibrine in any temperature, is in some measure its peculiarity, and on this account we are compelled to treat them as distinct substances. The idea, that the serum of the blood contains so much albumen that it cannot support the whole of it during rest or after death, but disengages part of it as fibrine, is highly improbable, as we have seen serum itself, i. e. water and albumen, secreted in the cavities of the body after death, just in the same way as during life, consequently without fibrine. According to Sigwart (Meckel's Physiol. Archiv. I. 2. S. 208.) the solution of albumen in caustic ammonium,

when precipitated by a solution of the corrosive sublimate, is again soluble in concentrated muriatic acid ; but this is not the case with fibrine, when precipitated in the same way.

Rem. 3. Ant. Heidmann (Reil's Archiv. VI. S. 417—431.) has shewn by experiment, that motion is not produced on fibrine when exposed to the action of the voltaic apparatus, as described by Tourdes and Circaud. On the contrary, he has ascribed the motion which took place in the blood without the action of the voltaic apparatus, but which he observed by means of the microscope, to the coagulation of the fibrine ; but this is evidently false also, as I can assert on the evidence of repeated observation. He has merely seen the motion of the globules of the blood, which he has not once mentioned, although he has spoken of the red part of the blood ; but at the same time, he has not sufficiently thinned the drop, or has laid too much on the object bearer, to enable him to distinguish the globules. From such microscopic observations, we can learn nothing with regard to the fibrine itself ; for this purpose it exists in too small a quantity in a drop, and its motion must partly cease with its separation in so small a quantity ; vide 160.

Rem. 4. Nothing has yet been detected in vegetables which can be compared with animal fibrine : and from their rigid structure, such a substance is not to be expected.

152.

Mucus is the secreted fluid of peculiar glands (*cryptæ muciparæ*), which are found to exist particularly in the mucous membranes ; it varies much as to its consistence, but is always tenacious, and may be drawn out in threads ; it is insoluble in alcohol and water, but absorbs a part of the latter, and thus becomes transparent ; when subjected to the action of heat, it neither coagulates, nor is changed to gelatine ; it is precipitated by tannin, and this precipitate, when dried, becomes transparent.

Rem. 1. Berzelius (Ueberblick, p. 48—55.) has compared the mucus of the nose, that of the air passage, the gall-bladder, of the intestines,

and urinary passages, with one another, and finds many distinctions in each, according to the parts with which it is in connexion, but none of any consequence. According to Berzelius, the mucus of the nose contains of—Water, 933.7; Mucous matter, 55.3; Muriate of potass, with soda, 5.6; Lactate of soda, with the animal matter which accompanies it, 3.0; Soda, 0.9; Albumen, and animal matter insoluble in alcohol, but soluble in water, together with a trace of phosphate of soda, 3.5.

Five parts of fresh mucus from the nose, in twenty-five parts of water, produce a substance which much resembles albumen. In short, mucus is a substance which closely approximates to albumen, but particularly modified, as may be expected from its being secreted from a peculiar order of glands. The very striking resemblance of albumen to mucus may be seen from the horny substance.

Rem. 2. The number of mucous glands situated in the lips, gums, tongue, gullet, throughout the whole of the intestinal canal, and contiguous biliary system, in the parts of respiration, in the urinary and generative systems, is, taken collectively, very great, and individually, very various; but they appear every where to be principally, or entirely, destined to protect the parts they supply with mucus. A similar mucous apparatus exists in fishes for the protection of the external surfaces of their body; 116. *Rem. 2.* Is this the object of the glands in the first stomach of birds, in the stomach of the beaver, &c.? or are they not rather to secrete a salivary kind of juice? It is the opinion of Sir Ev. Home, that the esculent nests of swallows are prepared from the mucus secreted by the glands of the stomach; but if we compare the smallness of this glandular apparatus with the size of the nests, we will find that this is a very unlikely circumstance.

153.

Water (Serum), is contained in the cellular membrane, and in all the cavities of the body (150), in the blood, lymph, milk, in the urine and other fluids, in the substance of all solid parts, and distinguishes itself from common, or inorganic water, with which it is often erroneously compared, chiefly

by the albumen it contains, which is found in it in various proportions.

The serum of the human blood is of a greenish yellow colour, and of a slightly salt taste; its specific gravity is about 1.027; it changes the violet infusion to a green, and the tincture of curcuma to a brown colour, which shews that it contains a free alkali. According to Berzelius, it consists of,—

Water,	-	-	-	-	905.0
Albumen,	-	-	-	-	80.0
Matter soluble in alcohol, viz. muriate of potass and soda,	-	-	-	-	6 } 10.0
Lactate of soda combined with animal matter,	-	-	-	-	4 }
Matter soluble in water only, viz. soda, phosphate of soda, and a little animal matter,	-	-	-	-	4.1
					<hr/> 999.1

The proportion of albumen contained in the serum of the cavities is equally as small as it is abundant in the above; so that Berzelius obtained from a thousand parts, taken from the brain of a hydrocephalic subject, merely 1.66, and in the aqueous moisture of the eye there was only a trace of it observable. For the analogous juice of the absorbent vessels, vide 166.

Rem. 1. The synovia of the ox, according to Margueron (in Thenard), contains of,—Water, 80.46; Albumen, 4.52; Fibrinous matter, 14.86; common Salt, 1.75; Carbonate of soda, 0.70; Phosphate of lime, 0.70. Vauquelin (ibid) found the synovia of the elephant to contain water, albumen, a few traces of white threads, which had the appearance of fibrine (?), carbonate of soda, carbonate of lime, muriate of soda and potass, besides a peculiar animal matter which was precipitated by tannin, but neither by alcohol nor acids. That fibrine frequently appears in the serum of the cavities after inflammation of these parts, is well known, but that it is a constituent of the synovia is not to be expected.

Rem. 2. We find it occasionally asserted in authors, that the water in cavities, viz. the brain, is completely evaporated; but when this is the case, it is decomposed, and we can never consider it (with Kant in *Soemmerring vom Seelenorgan*) as mere water.

Rem. 3. I cannot conceive how all authors have been brought to believe, that those animals which belong to the camel species preserved the common water which they drank in their stomach, when the analogy, and the peculiar structure of these parts, should have brought them to the conclusion, that a particular production of water took place in those parts. More may be found on this subject, but to the same effect, in Alex. Russel's *Natural History of Aleppo*, Ed. 2. Lond. 1794, Vol. 2. p. 425.

On the whole, the cases where camels are slain for the sake of the water secreted in the cells of their stomachs, are very seldom to be found in the journals of travellers; and according to Goolberry (*Fragmens d'un Voyage en Afrique*, T. 1. p. 357.), the relief it affords to caravans of travellers, perishing with thirst, is very trifling.

Just as erroneous is the idea that the water is collected from without in the sacks of the *Nepenthes destillatoria*; it is merely produced by vegetation, as in the stalk of some others. Leaving the usual explanation out of the question, we find much interesting and excellent matter, and which greatly tends to support my views on the subject, in Rob. Percival's *Description of the Island of Ceylon*, and in J. Barrow's *Travels to Cochin-china*. Even the excellent Rob. Brown (*Matth. Flinder's Voyage to Terra Australis*) entertains the unphysiological idea, that the water collects from without in the sacks of the *Cephalotis follicularis*. I am of this opinion with regard to the *Sarracenia*.

154.

Fat (*Adeps*, *pinguedo*, *oleum pingue*) is contained in the cellular membrane of almost all parts, but in man it presents in the greatest abundance in the orbits, about the kidneys, &c. in the bones, and (in very small quantities) in the horny substance. When pure, it is white, inodorous, and insipid; lighter than water; it varies in consistence according to the tempera-

ture, and other unknown causes, in the living animal ; it easily melts when the temperature is increased ; is insoluble in water, alcohol, and æther ; with alcalis it forms a soap.

Rem. 1. Fat presents in the human subject under three different forms. As common fat, in the cellular membrane ; as marrow (*medulla ossium*), in the bones ; and as adipocire, in the white crystalline gallstones, in degenerated muscles, in macerated bodies, and in the brain, which has lain long in spirits, where it forms crystals similar to spermaceti. The opinion of Gay-Lussac, that the flesh is not changed to fat, but is merely exposed by the putrefaction of the latter, and thus become separated from it, must appear objectionable to every one, who has compared sound muscle with that which, through disease, or after death by maceration, has been converted into adipocire, where no fibres are to be seen, even where no fat was previously to be found between the muscular fibres.

Rem. 2. Besides these, other peculiar fatty substances are found in the human body, as the wax of the ear, the Meibomian moisture, the grease of the skin.

Rem. 3. In animals the common fat appears under various forms, viz. somewhat hardened in the Ruminantia, as tallow (*sebum*) ; semifluid in swine and beasts of prey (approximating more to human fat) ; next in many birds, where it is denominated grease, or lard (*adeps*) ; fluid in whales and other fishes, which is called train-oil (*Oleum cetinum, piscinum*) ; and lastly, that secreted by whales under a form quite different from the common oil, as spermaceti (*cetaceum*), which I have seen in the cellular membrane of the head of the *Balæna Boops* as white and pure as snow.

According to Berard (vide Thenard) a hundred parts of swine-fat or lard consist of,—Carbon, 69 ; Oxygen, 9.66 ; Hydrogen, 21.34. Mutton fat of,—Carbon, 62 ; Oxygen, 14 ; Hydrogen, 24. Train-oil of,—Carbon, 79.65 ; Oxygen, 6 ; Hydrogen, 14.35. Spermaceti of,—Carbon, 81 ; Oxygen, 6 ; Hydrogen, 13.

Rem. 4. The acids considered by the old chemists as peculiar to fat, were merely the product of their operations, but no constituent of fat. Later chemists have considered various acids as existing in different kinds of fat, which likewise appear, in some measure at least, uncertain ; thus

Thenard has demonstrated a sebatic acid, which Berzelius considers as benzoic acid; Chevreul (in Thenard) has discovered in lard an acid which he calls the *acidum oleaginum*, together with the *acidum margarinum*, which distinguishes itself by its pearl colour. I have once observed this pearly appearance in a fatty tumour found in a human brain, so that we may expect the same to exist in this likewise.

Chevreul asserts, that he has discovered other substances peculiar to the various kinds of adipose matter, which he denominates *Stéarine*, *Elaine* (both existing in lard), *Cétine* (in train-oil), *Cholestérine* (in gall stones), and *Butirine* (in butter).

Rem. 5. The production and accumulation of fat in the animal body will be discussed in the special part of the work. We have only to remark here, that it is very easily produced, and is therefore very widely distributed through the animal kingdom, among insects and worms (*Linn.*), but in the latter less deposition of fat takes place than in the former. The fatty oil likewise, which is found to exist in so many vegetables, is exactly the same as common animal oil; and according to Chevreul it likewise consists of *Stéarine* and *Elaine*. According to Gay-Lussac and Thenard, a hundred parts of olive oil consist of,—Carbon, 77.21; Oxygen, 9.43; and Hydrogen, 13.36.

155.

Lactic acid (*Acidum lacticum, lactis*), is, according to Berzelius, a common constituent of the animal fluids,—of the blood, urine, milk, marrow, and also of the flesh, and presents itself partly free and partly in combination with *alcalis*. It has a brownish-yellow colour, a sharp, acid taste, which is quickly weakened by dilution with water. In the cold it is inodorous, but when heated evinces a sharp sour smell. It is not crystallizable, and dries to a tenacious clear varnish, which gradually becomes moist in the air. It is readily soluble in alcohol. With *alcalis*, earths, and metallic oxides, it forms peculiar salts, which are soluble in alcohol, and for the most part exhibit no disposition to crystallize, but dry to a gummy kind of mass, which slowly becomes moist in the air.

Rem. The Osmazome, as Thenard denominated it, and which is considered by the French chemists as a peculiar extractive matter of flesh, consists, according to Berzelius (Ueberblick, p. 29.), of lactate of soda, and of an animal matter intimately combined with it, which is separated by tannin.—It appears as a reddish-brown extract, of an aromatic smell, of a strong and pleasant taste, and is found in the flesh of the ox, and probably in other full grown animals whose flesh is dark and juicy; it exists likewise in small quantities in the brain, in the blood, likewise in oysters, even in the fungi and in the *Chenopodium Vulvaria*. It is on this that the strong smell and taste of beef soup depends, while that which is made from veal and fowls is destitute of it. It is on the presence of this likewise, that the strong taste of roasted and broiled flesh depends. In soup, it exists in a proportion to gelatine as one to seven. Vide Thenard's *Chimie*, Ed. 2. T. 3. p. 687. *Dict. de Méd.* T. 38. p. 381.

CHAPTER III.

OF THE GENERAL COMPOUND PARTS.

156.

The generally diffused parts, the composition of which it is now our object to consider, are: the *Blood*, *Lymph*, the *Cutaneous* or *Horny* parts, *Cartilage*, *Bones*, *Arterial fibres*, *Muscles*, and *Nerves*.

Rem. Very few of these parts have been compared, as they exist in the human subject, and in animals, with respect to their combinations, as will be seen by the following.

The *Blood* (*Sanguis*) is contained in the heart, and the vessels connected with it, the arteries and veins. A variety of opinion exists with regard to the quantity of the same; but if we consider the extent of the vessels, which are all filled with it, or the quantity of the mass which it requires to inject them after death; or the cases where people have borne an immense loss of blood without dying from it; or where men have been bled to exhaustion, and the blood received has admitted of an estimate, we will be compelled to consider the quantity of the blood as greater than it has been considered by many older and later authors; and if we take into consideration the specific weight of the blood, which, according to Haller, is 1.0577, according to Berzelius 1.053, we will find that Haller has by no means overrated the quantum existing in a full-grown person, when he estimates it from 28 to 30 pounds.

Rem. Blumenbach (Instit. Physiol. p. 6.) appears to agree with Allen Mullen and Abildgaard in considering the quantity of blood in the human subject as only amounting to 8 pounds. Sprengel (Instit. Physiol. l. p. 378.) considers it as varying from the tenth to the fifteenth, and sometimes to the twentieth part of the whole body, all of which appear to me to be too low. Haller very properly observes, that we ought not to look to those cases where so little blood has been found in animals, in which the large blood vessels have been cut. I have frequently cut the carotids of sheep in this manner, and have only obtained from two to three pounds of blood, and in some, which were younger, only one pound; but in these all the blood was by no means emptied from the body. And yet the estimates given by authors, depend solely upon the analogy of the blood received from slaughtered animals. John Hunter (Experiments on the blood, &c.), very justly remarks, that we have many and great difficulties to encounter in determining the quantity of blood, but on this account he supposes it to be very considerable.

Comparative views of the quantity of blood in various animals have not yet been made, but this much appears certain, that it is not regulated according to the degrees in which animals are classed by us. Treviranus (Biologie, IV. S. 564.) believes that the quantum of blood in snakes is very trifling; but Erman (see the work mentioned 141. *Rem.*) has obtained 77 grains of blood in a *Helix Pomatia* which weighed 437 grains, and 76 in another which weighed 465 grains; the vascular system of this animal is very great, as is shewn by some beautiful injections by Stosch, in the Anat. Museum. I have, when in Naples, injected many *Aplysiæ*, and certainly without any extravasation, by which I found the calibre of the vessels of these animals to be very considerable.

158.

When we contemplate the blood vessels situated in the transparent part of a living animal, viz. in the mesentery, or in the tail of a fish, in the swimming web of frogs, in the gill of the larva of the salamandra, we observe, according to the diameter of the vessel, a greater or less number of round or elliptical dark bodies swept along, which are distinguished by the name of blood-globules or vesicles (*Globuli, vesiculæ s. folliculi, sanguinis*). The fluid in which they float is a solution of a large quantity of albumen and some fibrine.

Rem. 1. J. Nath. Lieberkühn (Mém. de l'Ac. de Berlin, 1745) has invented an instrument, for the purpose of observing the passage of the blood through the vessels; this, however, is not required, the same object is effected by having an opening in the brass plate of the compound microscope, on which the animal is so fixed that the part which is under investigation appears immediately before the opening. The same object is frequently attained by means of an hour-glass, in which the object to be considered is placed. Plates of these vessels, on a magnified scale, may be seen in the work of Ge. Chr. Reichel, (*De sanguine ejusque motu*. Lips. 1767, 4to.), on the mesentery of the frog, and in Steinbuch's *Analecten* on the gills of the larvæ of the Salamandra.

Rem. 2. We can scarcely consider Ign. Döllinger (*Was ist Absonderung und wie geschieht sie. Würzb. 1819, 8vo, S. 21.*) as speaking seriously, when he says of the blood, that it cannot be considered as strictly a fluid, and that "it does not flow like water, but like sand from an hour-glass; that we might just as well consider a heap of peas as a fluid: we know not whether the blood-globules actually swim in a fluid or not," &c.

159.

The form of the globules of the blood cannot be conveniently determined, so long as the blood flows in its vessels; it is consequently necessary to place them on the object-bearer, which must be placed as soon as possible on the micrometer under the microscope, and this must be done, as soon as the finger has been scratched, or if from an animal, as soon as the blood has been taken from the vessel selected for the purpose, in order to have an opportunity of investigating the blood when quite fresh, and before coagulation has commenced. The human blood, like that of warm-blooded animals in general, remains but a very short time in a state fit for being investigated, for the globules in the blood of these are very quickly decomposed; in cold-blooded animals, as for example, in the turtle, it will remain twenty-four hours after death fit for this purpose; but when once spread out on the object-bearer, and exposed to the atmosphere, this quality is soon destroyed in them likewise. Brande (*Annal. de Chimie, T. 94. p. 53.*) says, that the colouring matter of the blood is only held in solution in the blood globules; according to Young's discovery, these themselves remain colourless, and swim on the surface: but I have repeatedly observed that the blood globules, having become white, presently lose their form and disappear. Where many of them are lying (fresh) on one another,

every part appears red, fewer together appear yellowish, and single ones white; whence the error into which Leeuwenhoek has fallen, who supposed each red globule to consist of six yellow globules, and each yellow globule of six white globules.—It is likewise possible, that they may be so situated with respect to each other, that they may appear to form a ring, which I have frequently observed, and by which Poli very justly explains the observation of Della Torre, who considered the globules of the blood to be of an annular form.

The globules of the blood of men, and other warm-blooded animals, are always of the same form when fresh, but they do not retain it long; they disappear individually, so that their figure becomes gradually indistinct; or they aggregate, so that we have larger bodies, vesicles of all varieties of form, until the whole mass can no longer be distinguished.

In man they are round; and I have found them of the same form in fishes (viz. in the *Perca fluviatilis*, *Pleuronectes Flesus*, *Platessa*, *Solea*), and in the *Pagurus*; I have, on the contrary, found them more or less of an oval shape in the common fowl, and the amphibia (*Chelonia Mydas*; *Emys Talapoin*; *Lacerta agilis*; *Rana viridis*, *temporaria*; *Hyla arborea*; *Triton palustris*, *Salamandra maculata*, *Proteus anguinus*); in the land salamander and proteus, they are extended more longitudinally, but the vesicles of all these amphibia, as well as the fowl, so long as they are fresh, appear on the convex surface with a slight degree of elevation (*umbo*).

Rem. Haller (El. Phys. II. p. 53. sq.) mentions the tottering and self-subversive proposition of Leeuwenhoek; but if we read it attentively, we immediately observe that it is little more than hypothesis, and requires no refutation. Later authors have availed themselves of the idea of the united blood globules in pathology, which they have some-

what refined, in order to explain the theory of inflammation as an error loci (by the pressure of these into smaller vessels than they were adapted for); and the same was applied to physiology in the doctrine of secretion. Haller again erred in supposing that all the globules were round; Sprengel (Inst. I. 379.), in supposing them all to be of an oval form.

Giov. Maria Della Torre (particularly in his *Nuove Osservazioni microscopiche*, Napoli, 1776, 4to.) has represented in his figures the various parts of these rings separated from one another. See likewise Jos. Xav. Poli, *Testacea utriusque Siciliae* (Parmæ, 1791—95, fol. T. I. p. 48.) who accurately adduces the same. Fel. Fontana (*Nuove Osservazioni supra i globetti rossi del sangue*. Lucca, 1766, 8vo.) has, on the contrary, explained Della Torre's opinion, by supposing him to have considered the point in the middle of his figures as a foramen.

Will. Hewson (*Experimental Inquiries*, P. III. containing a description of the red particles of the blood, &c. Lond. 1778, 8vo, p. 1—44.) has given much excellent matter on this subject, and on the whole very excellent figures. That the vesicles in the blood of the amphibia are not very globular is common, and these appear to be numerous in the human blood also, in which I have frequently observed the dark spot in the middle; but I can by no means consider them flat like a guinea.

The investigations of Gius. Aut. Magni: *Nuove Osservazioni microscopiche sopra le molecole rosse del sangue*. Milano, 1776, 8vo, which coincide with the observations of Hewson, are entitled to very great praise.

Gruithuisen's investigations (*Beiträge*, p. 87, 161.) are unsatisfactory; he appears either to have misunderstood Hewson, or not to have read his book.

160.

I have frequently examined the size of the blood globules taken from myself and others, and have always found them to be extremely small; my estimate of their magnitude

(like that of Blumenbach (*Inst. Phys.* p. 11.), which determines them at the 3300th, or of Sprengel (*Inst. Phys.* 1. p. 379.) at the 3000th part of an inch,) determines them to be from the 3000th, or the 3200th, to the 3500th part of an inch in diameter; so that the surface of a square inch contains nine millions of vesicles. In fishes, I found their diameter to be from the 2000th to the 2500th part of an inch; so that about four millions would cover the surface of a square inch. In the land salamander, the shortest diameter of the vesicles is, to the longest, as 7 to 10 nearly; hence it would require about seventy to cover the surface of the tenth part of a square line; consequently, the surface of a square inch would contain 700.000; thus they bear a proportion to those of the human blood as 12 and six-sevenths to 1. Their number is invariably less in proportion to their greater magnitude individually; thus the mass of the blood vessels collectively, is much greater in man than in any of the above-mentioned animals.

Rem. Laz. Spallanzani (De Fenomeni della Circolazione. Modena, 1773, 8vo, p. 210. *Expériences sur la circulation*. Paris, en 8vo, p. 226.) informs us, that the size of the blood vesicles of frogs is the same as that of their larvæ, but that the number in the former is greater; of this I have not had experience sufficient to judge. Poli asserts, that the vesicles in many of the mollusca (*Solen Legumen*, *Tellina nitida*, *Chama antiquata* and *calyculata*, *Arca pilosa*, but particularly of the very frequently investigated *Arca Glycymeris*.) are much larger than in man; so that he considers the latter to be to the former, as hemp-seed to millet-seed. I have observed the vesicles to be much larger in the punger, and similar observations are mentioned by Hewson. In investigating the blood of the proteus, I did not apply the micrometer, when the vesicles appeared to me to be greater than those of the salamander, and certainly they are at least equal to them. Those of the frog, the lizard, the turtle, and fowl, are only half the size at most, but these are much larger than in man, or even in fishes.—Sprengel must have erred in committing his remarks to paper, or it must have been the fault of his memory, when he describes (*Inst.* 1. p. 379.) the

vesicles of the fowl as being as small as those of man; they are twice the size, and resemble those of the amphibia in form, as drawn by Hewson, and described by Gruithuisen.

I have been thus detailed in the above subjects, as I have every reason to suppose, that in them will be found, at some future period, the key to very important physiological truths. In these, neither the form nor the size will be matters of an indifferent nature. Poli very justly remarks, when speaking of turgescence, or the collapse of the same, which he deduces from the vigorous or enfeebled state of the animal,—"Micrometrical investigations have their difficulties, still however, it would be unjust to neglect its assistance on such a subject."

161.

The vesicles of the blood are altogether destitute of any *peculiar motion*. We see the stream of blood in the vessels of living animals rushing forward without the vesicles exhibiting any motion peculiar to themselves, or without any change of form. When a drop of blood is placed on the object-bearer, a movement is observed which is caused by the action of the air, and which is increased when the blood is placed on a drop of water; this motion continues for a longer or shorter time, probably according to the various proportions of blood and water. The same thing is more evidently seen when the pollen of vegetables is placed among water, in oils, camphor, and many other substances. We have just as little foundation for considering them, like Eber, as infusoria, as for ascribing to them, with Döllinger, a peculiar course in the cellular membrane, external to the blood vessels.

Rem. 1. To judge of this matter, it is only necessary to compare the voluntary motions of the infusoria with the lifeless passage of the blood vesicles; 151. *Rem.* 3.

J. Hnr. Eber, *Obs. quædam helminthologicæ*. Gott. 1798, 4to, tab. —Döllinger, O. S. 23.

Rem. 2. The change of form in the individual blood vesicles, as accepted by Poli and others, effected by the contraction and dilatation of the vessels, must certainly be objected to; the appearance of this change arises from observing them at different times in a different focus.

162.

When blood is drawn from a vessel it has the appearance of a bright or dark red fluid, which is somewhat tenacious to the touch, and whose temperature is about 29° of Réaumur. (from 98 to 100° Fah.)

As long as the blood remains warm, a strong smelling vapour arises from it (*halitus sanguinis*), which ceases when the blood cools, but returns again when it is heated. It soon decomposes, becomes sour and putrefies, and the air in which it was retained becomes disagreeable, and looses its acid. Berzelius considers it as a very intimate constituent of the blood, which is dissolved in the serum; he likewise thinks that when it arises from other animal and warm substances, it is nevertheless ascribable to the blood or serum which moistens their vessels. The quantity of this vapour varies very much. According to Fourcroy, it is less in women and children, in men it is greater, and its odour stronger and rather rank. In eunuchs and old people, as likewise in those affected with spinal consumptions, it is altogether wanting.

Rem. Haller (*El. Phys.* 2. 38.) considers this vapour as the matter of perspiration; it appears to be at least connected with this, on which subject see the Special Part.

163.

During the process of cooling, the blood, when standing unagitated, coagulates sooner or later to a brittle gelatinous sort of mass, which takes on the form of the vessel in

which it is received. This mass becomes more and more firm, while a yellowish green moisture oozes from all sides—the *serum* of the blood (*serum sanguinis*), in which fluid a sort of cake (*crassamentum*, *placenta*, *hepar sanguinis*) is at last seen to float, the superior surface of which, viz. that which is exposed to the air, becomes of a red colour, while the inferior surface, on the contrary, exhibits a blackish hue.

The serum, the analysis of which by Berzelius is mentioned 153, constitutes the greatest part of the blood, but it varies very much in quantity; thus we find it to be much less in old people, and in those in whom any inflammatory action exists; but much more abundant in young persons and in those of a delicate habit.

The crassamentum consists chiefly of the *red* or *colouring part of the blood* (*cruor*), or of the blood vesicles (blood globules, 158—160.), and, in a much smaller proportion, of the fibrine (*fibra sanguinis*), which is described 151. According to the analysis of Berzelius, the proportion of the former to the latter is as 64 to 36.

Rem. 1. In the crassamentum the fibrine and colouring part of the blood are generally so intimately connected, that they are very difficultly and imperfectly separated from one another; in inflammatory diseases, on the contrary, during pregnancy, in old people, and in many other conditions, which perhaps we will never be able to trace to a common cause, the disposition to combination or mutual coagulation is suspended, and the red part of the blood taken from the vessel sinks to the bottom of the receiver, while the fibrine forms a covering over its surface, of a white yellowish or greenish appearance, of a thinner or a thicker texture, sometimes uniform, at other times hanging in an irregular manner about its edges, which has received its name from inflammation, in which it was first, and is still, most frequently observed, viz. the inflammatory crust, &c. of the blood (*corium pleuriticum*, *crusta pleuritica*, *inflammatoria*).

W. Hewson (An experimental Inquiry into the properties of the Blood, with remarks on some of its morbid appearances. Lond. 1771,

Svo,) attempts to explain the formation of this crust by attributing it to the more gradual coagulation of the thinned blood.—Can this not be explained by the various proportions of the cruor, so that the fibrine is not able to contain it when it exists in too great a proportion? Is not this likewise supported by the circumstance of the urine being at the same time saturated with colouring matter?

Rem. 2. There is one extraordinary case, connected with this subject, which came under my notice, equal to which I have no other to offer in support of this opinion :—A few years ago, when dissecting a middle aged woman, in whom the other genital organs were regularly constructed, I found one of the Fallopian tubes distended with a dark, red, tough mass, which was quite foreign to me. I therefore sent it to our immortal Klaproth for investigation. He returned it in a calcined state; and had found, to his astonishment, that it contained nothing but the red part of the blood, without any appearance of serum. This had only been contained in a small quantity in the extravasation, and had become separated and absorbed; vide 167. *Rem. 1.*

164.

From chemical experiments made on the *cruor*, a very great affinity is, on the whole, observed between it, albumen, and fibrine, which, however, has been overrated; for the red colour of the former belongs to it exclusively, fibrine coagulates in all temperatures, and albumen only at a great heat; further, the colouring matter may be dried, without losing its solubility in water, or diminishing in bulk during exsiccation, by which it is rendered black, hard, difficult to pulverize, and breaks with a glass-like fracture; and lastly, the cruor distinguishes itself from the others, by its ashes containing a portion of oxide of iron.

Berzelius burnt four hundred grains of the colouring matter until the carbon was completely dissipated, and obtained five grains of yellowish red coloured ashes. This was found to be a compound of,—

Oxide of iron,	-	-	-	50.0
Subphosphate of iron,	-	-	-	7.5
Phosphate of lime, with a small quantity of phosphate of magnesia,	-	-	-	6.0
Pure lime,	-	-	-	20.0
Carbonic acid and loss,	-	-	-	16.5

As none of the finest re-agents on iron can detect its presence in the colouring matter, and as we are unable, by means of the strongest acids, to disengage either the iron or phosphate of lime from the blood, notwithstanding that we obtain it from its ashes: it follows, that neither of them exist in the blood in the form of a salt; but it is highly probable, that the blood contains the *base of these salts* in another form of combination, and that the phosphate of iron, like the earth of bones, is the product of combustion.

Rem. 1. The opinion of Fourcroy, viz. that the colouring matter is a solution of the red subphosphate of iron, in albumen, is contradicted by the experiments of Berzelius, which shew that the iron is easily separated from such a solution. H. Grindel (Hufeland's Journ. 1811. St. 1. S. 24. St. 8. S. 98. 1812. St. 2. S. 99.) believed that he had demonstrated the hypothesis of Fourcroy by means of the Voltaic battery, because he produced by its influence a mixture of albumen, white phosphate of iron, common salt, and water, to which he afterwards added carbonate of ammonia; but the redness which arose from this process was occasioned merely by the solution of the oxidized gold wire of the battery, as represented by N. W. Fischer (Hufeland's Journal, 1811. St. 12. S. 43.).

Rem. 2. Our late excellent chemist, Val. Rose, obtained three grains of metallic iron from a pound of blood taken from a healthy person, Meyer's Physiologie, S. 157.

The cruor, without doubt, acquires its red colour from the iron it contains in so considerable a quantity. This colour, however, becomes modified by the action of atmospheric air,

or of the oxygen it contains ; by the action of air, containing carbonic acid, &c. ; but we shall discuss this subject in the Special Physiology, under the doctrine of respiration. When once our knowledge of the vesicles of the blood shall no longer be isolated nor unconnected with chemical analysis, we shall then have a breach filled up, which, at present, can only be hinted at.

Rem. I consider the application of re-agents on the blood under the microscope, the experiments of Magni, &c., mentioned 159., to be entirely useless ; as we have here too small and too changeable a focus to enable us to observe the vesicles properly, which is a thing extremely difficult ; and particularly, as the blood is so easily decomposed by the air. More perhaps might be obtained by experimenting for some time on one and the same animal species, by infusions into their veins, and by chemically and microscopically investigating the blood when thus acted on.

166.

The aqueous moisture or lymph (*lymph*), which is taken up by the absorbents, is seldom present in a sufficient quantity to enable us properly to investigate it ; and in the principal trunk or thoracic duct (*ductus thoracicus*), the chyle is likewise contained, and generally forms the greatest part of its contents, so that the analysis of the contained fluid concerns it principally.

S. Th. Soemmerring (Vom Bau des menschlichen Körpers. IV. Th. Gefäßlehre. Frkft. a. M. 1801, 8vo, S. 535, 541.) has, however, had a very rare opportunity of observing a widely distended or varicose absorbent through the skin, on the back of the foot, in a masculine, strong female, who was affected with a diseased growth of the knee joint, which, when punctured in a distended part ; which might be done by a needle without exciting pain, pressed the lymph at first out in a stream, which afterwards ran down the foot as the blood from a vein, until by pressure beneath the puncture, or spontaneously after

the lapse of a few hours, the flow ceased. The appearance of the juice was bright, transparent, approximating to a pale yellow; the taste saltish. Alcohol and mineral acids rendered it opaque, so that after a few hours a precipitate was seen. At a gentle fire, or spontaneously when evaporated in flat vessels, it left behind a transparent, gum-like, elastic, and golden-yellow coloured part, on which a few fine crystals of salt were formed. When evaporated to one-half over the fire, it became gelatinous. When placed in a temperature of 50° Fah. (8° Réaum.) for a few weeks, it became putrid, opaque, and acquired a carrion-like smell, and at the same time a disgusting aspect. Sublimate produced an opal kind of opacity and a sparkling redness, after which it did not putrefy.

Brande (*Annals de Chimie*, T. 94. p. 43—45.) investigated the lymph found in the thoracic duct of animals which had fasted above twenty-four hours. It was found miscible in all various proportions with water; produced no change of colour in vegetable juices; was coagulable neither by heat nor acids; alcohol produced a slight degree of opacity; the action of a galvanic battery of twenty-four zinc and copper plates, of four inches, attracted to the negative pole a few flocculi of albumen, and an alcali; and to the positive pole an acid which appeared to be muriatic acid; by evaporation, a small residuum was produced, which reddened the syrup of violets; this residuum contained a small quantity of muriate of soda, but no trace of iron.

Rem. 1. It thus appears that the lymph is very simple in its composition, but when it has received the chyle, which will be treated under Special Physiology, it acquires a greater similarity to the blood. Was not the long continued fasting, in Brande's case, to be considered as the cause why the lymph in the thoracic duct appeared more simple than the lymph in the vessels of the foot, related by Soemmerring? Or is the long retention of the lymph in the varicose absorbents of this latter case, to be considered as producing a greater degree of saturation in it?

Rem. 2. It is somewhat singular that Brande has not named the animals on which he instituted his experiments; but from having made them in company with Sir Ev. Home, it is very probable that they were asses or horses, on which animals this gentleman is well known to have made his experiments with regard to the spleen.

167.

The analysis of the solids, (in plants as well as animals) is attended with still greater difficulties than that of the fluids, as it is so difficult, and frequently impossible, to be able to investigate them individually, but only in combination with other substances; and therefore very little can be said on this subject with certainty.

Rem. 1. It is common to all the solid and fluid parts of the human body to acquire the yellow tinge in jaundice. When the disease is in a lower degree, the aqueous fluids, the crystalline lens, and cutaneous parts, are alone discoloured; but afterwards the tendons, cartilages, and bones; and, at last, the medullary substance of the brain and nerves, become affected in the same way. On the contrary, when an animal is fed on madder, the earth alone is observed to take on the colour, and the bones become red, while no change of appearance, even in the cartilages, can be discovered.

I have once observed a case (and my respected colleague, Knappe, has also seen one), which still appears to me somewhat enigmatical. In the body of an old cachectic woman, where all the solids, and particularly the liver, were affected with a morbid softness and disposition to putridity, there appeared on the uterus, on the broad ligaments, on the cavity of the abdomen higher up, on the omentum and mesentery, smaller and larger, oblong and round tumours (from the size of a pea to that of a walnut), of a perfect vermilion colour, which, however, was only external; internally, it exhibited a white mass, like hardened albumen.

Rem. 2. We see how very little many of our means of investigation are of avail, from the observation that so many different solid parts likewise pass into gelatine, while they appear to the anatomist to be very different from each other.

The *cellular substance*, as well as the serous membranes which are formed solely from it, resists the action of cold water for a considerable period, and swells out to a frothy threaded substance, which after some time becomes putrid, and dissolves. By boiling, it at first shrinks and becomes firmer, but presently softens, and at length slowly dissolves to gelatine; so that by boiling flesh in the common way, it is easily distinguished, and also a stringy substance remains behind in the solution. In alcohol it becomes still firmer, and protrudes more, so that however well a preparation may be made, it soon loses its appearance in this fluid, and must be prepared anew. When dried, it is just as little of a yellow colour as when boiled.

We must not overlook this circumstance, viz. that the cellular membrane cannot be investigated free from other substances, but always contains absorbents, and generally other vessels, at the same time; and that this is the case in a much greater degree with the skin and mucous membranes, in which we have nerves, glands, &c. present, as well as the membranes themselves. Thus these latter membranes putrify the more easily the more complicated their texture; but on the whole, they exhibit the above-mentioned distinctions of cellular membrane.

Rem. I hereby bring myself back to the second Book of this work (112—117.), as chemists, for the most part, have not entertained the most accurate views respecting the various membranes, nor *can* they have, from the wavering notions of anatomists.

The *horny parts* (*cuticle, hair, nails,*) consist, according to John, for the most part, of 90 parts out of 100, of a mucous-like, hardened albumen, which is soluble only in the Papinian

vessel. Besides this mucous-like substance, Vauquelin found the black hair to contain a small quantity of a white, crystallizable oil (like spermaceti), and another of a greenish black colour, which was of a thick consistence, something similar to pitch, a little phosphate and carbonate of lime, oxide of manganese, and oxidized or sulphuretted iron, a considerable quantity of silica, and still more sulphur. Red hair contains a red, instead of the greenish black, oil, and less iron and manganese than the former. White hair contains a little phosphate of magnesia, and less of the coloured oil than the red and black hair. Berzelius (Djurkemi, 2. p. 271.) supposes the colour of the hair to arise from albumen and the colouring matter of the blood, and considers it extremely doubtful whether the oil detected by Vauquelin existed previously in the hair, or arose from the action of alcohol. That peculiar oils are not the cause of the various colours of the hair, is taught us by our own experience;—that black hair, even that of the Negro, will in process of time become red, and at last white, when kept in spirits in anatomical museums (viz. in our own, and that of Osiander in Göttingen). The variety of colour observed in hair and the horny tissue, depends on the greater or lesser quantity of the latter substance, in the same way as the many various colours of the iris arise from the greater or smaller size of its pigment.

Rem. Various metallic oxides and other colouring matters very easily produce an effect on the horny parts. The ancient eastern custom of colouring the finger-nails with Alcanna (*Lawsonia inermis*) is well known, and I have seen the nails of Egyptian mummies remaining reddened with it even to this late period. The hair of copper-smiths becomes green, oxide of lead turns it black. How many various colours (*Bixa Orellana*, *Carthamus tinctorius*, &c.) are used for colouring the skin in all regions! but in living beings it is only temporary, as the horny parts are constantly reproduced, and therefore require to be

tinged afresh. Before the colour can stand it must penetrate into the cutis vera, as is done in tattooing.

170.

Cartilage, when boiled, is converted into gelatine, with the exception of a few (vascular-) threads, and this takes place so much the more easily, the younger the animal from which it is taken. The redness which appears externally in the cartilages of young subjects during maceration, and on the divided surface when its substance is cut through, is considered by Berzelius to arise from an oxide of iron contained in it. It is a sanguineous colour which appears, and there is more blood in the cartilage of young subjects. And further, I have never seen this redness in the cartilages of old people.

171.

Bones consist of a cartilaginous substance and the earth of bones, i. e. of a lime combined with the phosphoric, carbonic, and fluoric acids. The earth contained in the bones (at least for by far the greatest part), and particularly those of young animals, is easily soluble in diluted mineral acids; so that a cartilage retaining the original form of the bone remains, which by maceration, is converted into cellular membrane, or to a mucus combined with fibres. Berzelius considers these vascular fibres to form somewhat more than the one hundredth part of the bone; but this, like the proportion of earth itself, must vary considerably according to the age of the subject. In the Papinian vessel, the cartilage of the bone is completely destroyed, and the remaining earth is equal to two-thirds of the bone. The same quantity of earth remains when the bones are calcined. In dry air, the bones retain their form for a long time, so that all the soft parts are

not lost by it. They are, however, at length destroyed by its operation, and fall to pieces.

According to Klaproth (vide Berzelius), human bones consist of,—

Cartilage, completely soluble in water,	-	32.17
Vessels,	- - - - -	1.13
Phosphate of lime,	- - - - -	50.96
Carbonate of lime,	- - - - -	11.30
Fluate of lime,	- - - - -	2.08
Phosphate of magnesia,	- - - - -	1.16
Soda, and a small quantity of muriate of soda,		1.20

Berzelius found the analysis of the bones of the ox to vary very little from this, viz.

Cartilage and tendons,	- - - - -	33.30
Phosphate of lime,	- - - - -	55.35
Fluate of lime,	- - - - -	3.00
Carbonate of lime,	- - - - -	3.85
Phosphate of magnesia,	- - - - -	2.05
Soda, and some of the muriate of soda,		2.45

The *osseous substance of teeth* is somewhat denser; in other respects it is similar to other bones: Berzelius has found those of the human subject to consist of,—

Cartilage and vessels,	- - - - -	28.00
Phosphate of lime,	- - - - -	62.00
Fluate of lime,	- - - - -	2.25
Carbonate of lime,	- - - - -	5.30
Phosphate of magnesia,	- - - - -	1.05
Soda, and muriate of soda,	- - - - -	1.40

From the teeth of the ox the same author obtained of,—

Cartilage and vessels,	- - - - -	31.00
Phosphate of lime,	- - - - -	57.36
Fluate of lime,	- - - - -	5.79
Carbonate of lime,	- - - - -	1.38

Phosphate of magnesia,	-	-	-	2.07
Soda, and muriate of soda,	-	-	-	2.40

The enamel of the teeth distinguishes itself essentially from the bony part by the absence of cartilage in it; and Berzelius obtained from that of the human subject, of,—

Phosphate of lime,	-	-	-	-	85.2
Fluate of lime,	-	-	-	-	3.3
Carbonate of lime,	-	-	-	-	8.0
Phosphate of magnesia,	-	-	-	-	1.5
Soda, together with a small quantity of brownish membranes, and water,	-	-	-	-	2.0

The enamel of oxen consisted of,—

Phosphate of lime,	-	-	-	-	80.90
Fluate of lime,	-	-	-	-	4.10
Carbonate of lime,	-	-	-	-	7.10
Phosphate of magnesia,	-	-	-	-	3.00
Soda,	-	-	-	-	1.34
Membranes, vessels (?) and water,	-	-	-	-	3.56

Rem. 1. The proportions of earth in the teeth vary very much. I found by former experiments that the teeth of the porpoise (*Delphinus Phocæna*) and of carnivorous animals, as likewise those of man, were much more easily soluble than those of the ruminantia. During the progress of the solution of the enamel, we observe it lying scattered on the bony part like lime. In the bony substance of the teeth of young people and animals, we observe cracks arising in those parts where the bony portions of the crown are united together.

Rem. 2. In all the bones of vertebral animals we find the phosphates of the bony earths predominating, and the carbonates in a smaller quantity; but the proportions of the latter to cartilage vary much; thus, for example, in fishes the cartilage predominates.

According to Hatchett's interesting experiments (*Philos. Trans.* 1799, P. 2. p. 315—334. 1800, P. 2. p. 327—402.), the bones and shells of invertebral animals differ considerably from this, as the car-

bonate of lime either presents alone or at least predominates. The craw-fish and crab contain the earthy carbonate in a greater quantity than the phosphate; the same remark applies to the Echinus, and likewise to the *Asterias papposa*; but in the *Asterias rubens* nothing but carbonate of lime can be detected. Carbonate of lime exists alone in those of the Testacea, but in various proportions to the soft parts, thus, for instance, in the *Cypræa*, the proportion of the former is very great, while it is very limited in many of the muscles, land-snails, &c. The *Os sepia* also, contains only the carbonate of lime. The stems of Zoophytes contain for the most part the carbonate merely, but sometimes there is likewise a little phosphate of lime; and in them likewise, the proportion of the soft to the earthy parts is extremely various.

172.

Tendons, and *tendinous membranes*, may be converted into gelatine, by boiling them in closed vessels; during the process they swell, become yellow and semi-transparent, and before passing into gelatine, they become mucose. They leave only a small quantity of fibrous substance behind, which of course arises from the vessels they contain. Their solution is quickened by the addition of dilute acids. The acid solution is not precipitated by alcalis nor the prussiate of potass, and contains no tendons; when dried they become hard, transparent, yellow, and horny; in water they recover their original form. They are acted upon very slowly by maceration, and by this means it is also difficult to represent their fibres, and still more so to boil them to a jelly.

173.

The *arterial fibre* (94.), according to Berzelius, is quite insoluble in water, and after boiling it for two hours it does not render the water in the least clouded, and nothing is precipitated from it by tannin. Its relation to the acetic,

muriatic, nitric, and sulphuric acids, and caustic potass, is also quite different, from a solution of which the acids throw down no precipitate. As no part of these arterial fibres is soluble in water, there is consequently no taste of flesh in the water in which they are boiled.

Rem. I know of nothing which resembles these arterial fibres more than the fibres of the uterus, and to these we may add those fibres which have undergone inflammation (viz. of the surface of the heart and its vessels, generally called pericarditis). The analysis of these is very much to be desired.

174.

The *muscles* are parts which are of an extremely compounded texture, but that part which constitutes their base, the muscular fibre, shews itself by analysis, to be similar to the fibrine of the blood (151.). The red colour which they possess is not peculiar to them, and by cutting the muscles into parts sufficiently minute, it may be completely extracted. By long maceration they are converted into adipocire.

Berzelius, from the medium of his experiments, found the muscles to consist of the following substances ;

Solids.

Muscular fibres, vessels, and nerves, - -	15.8
Fibres and cellular membrane, dissolved by decoction, - - - - -	1.9
	<hr/>
	17.7

Fluids.

Muriate and lactate of soda, - - -	1.80
Coagulated albumen and fibrine, - -	2.20
	<hr/>
	4.00

<i>Brought forward,</i>	-	-	-	-	-	17.7
ditto.	-	-	-	-	-	4.00
Phosphate of soda,	-	-	-	-	-	0.90
Extractive, soluble in water only,	-	-	-	-	-	0.15
Phosphate of lime, with albumen,	-	-	-	-	-	0.08
Water and loss,	-	-	-	-	-	77.17
						<hr/> 82.30
						<hr/> 100.00

Car. Christ. Sass, *De proportionibus quatuor elementorum corporum organicorum in Cerebro et Musculis*. Kil. 1818. In an Extract by Pfaff, in *Meckel's Arch.* V. S. 332—343. According to the investigations of this author, one hundred parts of dried muscular substance consist of,—

Carbon,	-	-	-	-	-	48.30
Hydrogen,	-	-	-	-	-	10.64
Nitrogen,	-	-	-	-	-	15.92
Oxygen,	-	-	-	-	-	17.64
						<hr/> 92.50
Fixed salts,	-	-	-	-	-	7.50
						<hr/> 100.00

Rem. In Berzelius's *Djurkemi*, 2. p. 178. the muriate and lactate of soda are marked 18.0, which of course is a typographical error.

175.

The *nervous substance*, as well that of the brain and spinal marrow, as of the nerves themselves, consists of an albumen peculiarly crystallized or coagulated into fibres, a fatty substance resembling adipocire, but which, like many salts, is only situated between its fibres.

According to Vauquelin, one hundred parts of human brain consist of,—

Water,	- - - - -	80.00
White fatty matter,	- - - - -	4.53
Red fatty matter,	- - - - -	0.70
Osmazome,	- - - - -	1.12
Albumen,	- - - - -	7.00
Phosphorus contained in the white and red fat,	- - - - -	1.50
Sulphur and various salts, among which are superphosphated alcali, phos- phate of lime and magnesia,	-	5.15

According to Car. Christ. Sass (see preceding section), one hundred parts of dried cerebral substance, amounting to 18.50 of fresh brain, consist of,—

Carbon,	- - - - -	53.48
Hydrogen,	- - - - -	16.89
Nitrogen,	- - - - -	6.70
Oxygen,	- - - - -	18.49
		<hr/>
		95.56
Phosphorus,	- - 1.08	} 4.44
Sulphur and salts,	- - 3.36	
		<hr/>
		100.00

According to John, the cineritious substance of the brain of the calf consists of 75 (to 80) parts of water; 10 parts of insoluble cerebral albumen of a very soft texture, containing a little soluble cerebral albumen; and 15 parts of various kinds of matter, viz. animal matter, soluble in water and alcohol, probably composed of the lactate of an alcali and animal matter; of matter soluble in alcohol but not in water; of uncrystallizable fat of a silky appearance; phosphates of lime, soda, ammonia, and magnesia; a sulphate;

muriate of soda ; traces of oxide of iron, probably with phosphoric acid.

The medullary substance of the spinal marrow distinguishes itself, according to John, from the cineritious substance, by containing more fat and a firmer albumen.

CHAPTER IV.

OF THE MOST GENERAL CHEMICAL PROCESSES OF THE HUMAN BODY.

176.

We can conceive no just idea of the substances which compose the human body, unless we take into consideration the manifold relations which they bear to each other, or the mutual actions they produce, and these actions again as chemical processes, or at least as accompanied by such. While some substances relax, and others come into action, while the fluid becomes rigid, and the rigid part is softened ; at each convulsion of a nerve, at each oscillation of a muscle, not only in effecting the equilibrium between parts, but in supporting them in it,—the whole system is every where in chemical action.

Rem. The chemical processes of inorganic bodies were formerly considered as limited, and as something more than this was observed to exist in the living body, it was laid down as a rule that, *it is a characteristic of the living body, that it is not subject to chemical laws.* But these laws are of two descriptions ; some are general, to which all

natural bodies are subject; others are special, and of these each order of creatures has those which are peculiar to it.

177.

The general chemical processes exhibit certain appearances so striking and characteristic in bodies, that we are easily induced to attribute them to peculiar substances, instead of considering them as the effects of the general chemismus. Thus we have associated with the constituents of our body a peculiar class of imponderable substances, viz. *Caloricum* or *Thermogenium*, *Photogenium*, and *Electrogenium*.

Rem. To determine the contested point, Whether these are or are not peculiar substances, belongs to the province of natural philosophy. Either of these is sufficient for our purpose; and to a lecturer on physiology it may be permitted to wave the question, and to choose those which seem to be of more moment. It appears to me to be somewhat contradictory to talk of caloric, &c. as a peculiar *matter*, and much more so, to admit of a peculiar matter of smell or of sound, which will be considered at length under Special Physiology.

178.

A *peculiar caloric* seems to exist in all organic bodies without exception; but in plants it exhibits a much greater degree of changeableness, and at the same time a greater dependence on the temperature of the atmosphere; whence it is denied them altogether by some natural historians, as Nau and Treviranus. The observations of Hunter, Schöff, Solomé, and Hermstädt, on the contrary, appear to set it beyond a doubt, if even our daily experience is not already adequate to it. While we perceive the stems and roots of trees exhibiting in winter little or no difference of temperature from the external atmosphere, the same thing takes place in many torpid animals, whose peculiar caloric we would not deny, if we even had not observed them in this asphyxia. On the con-

trary, we evidently see that plants are variously circumstanced with regard to external temperature, according as they are strong, or weak and delicate, and particularly, according as they are living or dead, and that which has been once killed by frost never returns again to life.

Some plants, while blossoming, develop a considerable degree of warmth, as was first observed by Lamarck in the *Arum italicum* ; and respecting which circumstance, Hubert instituted a great number of interesting experiments on the *Arum cordifolium*, in the island of Bourbon, the spadices of which, at a temperature of 21° Réaum. developed a heat of 45° Réaum. and upwards ; Bory de St. Vincent likewise observed the same circumstance, although in a lower degree, in the *Arum esculentum*.

Rem. 1. Nau in: *Schriften der Wetter. Gesellsch.* I. 1. S. 27—36. —Treviranus *Biologie*, Th. 5. S. 4.—John Hunter (*Phil. Transact.* 1778. P. 1. p. 7—49.) Of the heat of Animals and Vegetables.—J. Dav. Schöpf, Ueber die Temperatur der Pflanzen, im *Naturforscher* St. 23. S. 1—36.—Solomé (*Annal. de Chimie*, T. 40. p. 113—122.) Obss. sur la température interne des végétaux.—Bory de St. Vincent, *Voyage dans les quatre principales îles des mers d'Afrique*, T. 2. Paris, 1804, 8vo, p. 66—85.

Link (*Grundlehren der Anatomie und Physiologie der Pflanzen.* Gött. 1807, 8vo, S. 229.) attempts to explain the appearance of warmth in the *Arum italicum* by an oil or carburetted hydrogen gas being disengaged in the air ; but the experiments of Hubert contradict such a supposition, as even the internal parts of the bud were hot ; the male and female organs exhibited different degrees of temperature ; a light was extinguished in the air in which the buds were kept ; the warmth remained when in carbonic acid and hydrogen gas, nor were they deprived of it by excluding the light.

Rem. 2. The residence of many oscillatoria in hot water, leads to no general conclusion, as they are situated equally between the commencement of the animal and vegetable kingdoms. Again, when some few plants are met with having the roots situated in hot springs, it is only a

part of their root which is so situated, and, it may be asked, how have they borne it in the sequel?

Rem. 3. I shall define the heat in what follows always according to Réaumur, as is customary in Germany. I should otherwise rather have adopted the centigrade thermometer; the degrees of Réaumur, however, may easily be converted into those of the other thermometer, as those of the former are to the latter as 4 to 5. English authors generally use the thermometer of Fahrenheit. In order to obtain from it the number of degrees according to Réaumur, subtract from the given number 32, multiply the remainder by 4, and divide the product by 9. When the sign of *minus* is not expressly marked, the numbers must always be considered as *plus*.

Rem. 4. On account of the great difference between thermometers, viz. of the smaller ones, whose calibers are seldom accurately formed, many of the following calculations must appear either too high or too low. But in determining the internal temperature of the animal, in respect to that of the external atmosphere or surrounding medium, this difference is of little importance as concerns our purpose.

179.

Internal heat varies very much in different animals. Worms, (*Linn.*) crustacea, some insects, fishes, and amphibia, enjoy a very low temperature, while that of the other insects, mammalia, and birds, is very high. The temperature in man is about the same as in the higher mammiferous animals.

Rem. Several authors on this subject will afterwards be referred to; I will merely mention for the present: Ge. Martinii, de similibus animalibus et animalium calore libri duo. Lond. 1740, 8vo, also his Medical and Physical essays. ib. cod. 8vo. †—Arn. Duntze, Diss. complect. varia calorem animale spectantia. L. B. 1754, 4to.—Ant. Rolandson Martin, Thermometrische Bemerkungen über die Wärme im menschl. Körper. In the Swedish Transact. of 1764, p. 299—317.—J. A. Braun, N. Commentar. Petrop. T. 13. Petrop. 1769, p. 419—435. De calore animalium.—J. Hunter, Expp. and obss. on certain parts, &c. p. 99—128. from the Philos. Trans. of 1775, 1778.—Pet. Sim. Pallas, Novæ

Species Quadrupedum e Glirium ordine. Erlang. 1778, 4to, contains many observations on this subject; but I am in possession of much more in his manuscript remarks, which I shall afterwards mention among others.—C. Wilh. Juch, *Ideen zu einer Zoochemie*, 1. Th. Erfurt, 1800, 8vo, S. 90—140. *Von der Wärme als Product der belebten Welt.*—S. 141—158. *Ueber die Wirkungen der Wärme der belebten Welt.*—Ant. Boin, *Diss. sur la chaleur vitale*, Paris, 1802, 8vo.—C. Fer. Becker's *Abh. von den Wirkungen der äusseren Wärme und Kälte auf den lebenden menschl. Körper*, Gött. 1804, 8vo.—Thom. Buntzen, *Beitrag zu einer künftigen Physiologie*, Kopenh. u. Lpz. 1805, 8vo.—Franc de la Roche, *Mém. sur la cause du refroidissement qu'on observe chez les animaux exposés à une forte chaleur.* *Journ. de Phys.* T. 71. (1810) p. 289—302.—Nasse, *über die thier. Wärme in Reil's Archiv* XII. S. 404—446.—W. Kriemer, *Versuche über die thierische Wärme in his Physiol. Unters.* S. 174—185.—Petr. Jungersen Estrup, *Comm. de calore febrili adaucto et diminuto*, Havn. 1819, 8vo.

180.

Worms (Linn.) have all, or for the most part, a degree of heat, which varies little from the temperature of the medium in which they live. Many of them exist in a temperate medium, viz. in sea water, particularly that of warm regions; some of them become torpid from intense cold, and by this means escape being injured by it; others live in a very warm temperature, and appear to possess a lower degree of heat. I will mention a few examples of it.

We observe in those intestinal worms (*Entozoa*) which exist in warm-blooded animals, a great dependence on the external temperature, so that in the dead animal which is become cold, or in cold water, they become torpid, and may be again roused from this state, by the application of warm water. (Compare my *Historia Entozoorum*. Amst. 1809, 8vo, T. II. P. 1. p. 443. and my *Synopsis Entozoorum*. Berol. 1819, 8vo, p. 290. n. 51.) But they feel even colder to the touch, and scarcely ever possess the same heat as the animal

in which they are found. Those which are found in cold-blooded animals not only endure the cold without injury, but likewise a very high degree of heat.

Hunter (l. c. p. 117. Exp. 30, 32. p. 118. Exp. 37.) has instituted some experiments on the annulata, the earth-worm and leech. He never observed the leech restored to life after being frozen, nor even the earth-worm (p. 125); J. H. L. Kunzmann (Anat. physiol. Untersuchungen über den Blutegel. Berlin, 1817, 8vo, S. 98.) has found the leech killed by ice, and yet not in a frozen state. He mentions, however, the narration of Falk, which contradicts his own observation; and I myself have observed intestinal worms, which indeed stand lower than the former, that, when I placed them, together with the ice in which they were frozen, in cold water, they became very lively, and lived a whole day afterwards. Hist. Entoz. II. 1. p. 62. Obs. 3.

The experiments instituted on the mollusca, viz. some made by Hunter on the *Limax ater* and a common snail, are of very little consequence (l. c. Exp. 31. and 36.). It is probable, that they resemble in this respect the amphibia and fishes.

Rem. I found the small snails on the 16th of April, 1817, very plentiful in the hot springs (23° R.) of Abano near Padua, which Dom. Vandelli (Dissertationes tres. de Aponi thermis, &c. Patav. 1758, 8vo, p. 51—58. and Tractatus de thermis Patavinis. ib. 1761, 4to, p. 114.) describes as a *Buccinum*, and which the distinguished Ranzani of Bologna denominates *Cyclostomum thermale*. Three days had elapsed before I could examine them, when (19th) they appeared to be dead in the sponge in which I had placed them in the glass. But in warm water of 23° they again began to move, stretched out their antennæ, &c.; they moved quite lively also in water at 30°. At 35—36° their motion ceased, but returned again in some, as the water was cooled to about 20°; at 10° motion was completely suspended, and on the same day they could not be re-animated by heat.

I likewise made some experiments with the *Helix Pomatia*.—When

the water was heated to about 36° , it appeared to be completely lifeless, but was re-animated by lowering the temperature, which is no slight evidence of the independence of their temperature. Their heat in summer must also be less than that of the atmosphere, which appears from the coldness they evince to the touch.

181.

Crustacea do not feel so cold as the water in which they exist. I made some experiments in January on two specimens of the *Astacus fluviatilis*.—In a room at 12° of temperature, the water was at 9° ; on placing the thermometer in the body of one, it rose to 10° , and in the other to 12° , which I repeated several times. I then tried them in another room at 5° of heat, and again found 10° in the body of one, and between the muscles of the tail; in the other 12° , which gradually fell to 10° , which was the same temperature as the other, and there it remained.

182.

Braun's opinion respecting *fishes*, (l. c. p. 427.) after having made several experiments on various kinds, as, pikes, eels, carps, lampreys, &c.—is, that they merely exhibit the temperature of the surrounding water, whether this be cold or warm. * He therefore doubts the accuracy of the experiments of such authors as have expressed a different opinion, viz. that they have found their temperature to be higher than that of the water in which they exist. But the manner in which he performed his experiments, as related by himself, affords sufficient cause to doubt the accuracy of his own; and I find it mentioned in the manuscript of Pallas, that Braun used so large a thermometer, that Pallas cannot conceive how he has been able to insert its bulb into

the bodies of such small animals. Thus the water which surrounded the fish, must naturally have prevented the accuracy of the experiments.

I have only made experiments on this subject on a weak *Torpedo marmorata*. The heat of the room (at Naples, in the month of July) was at 21° and one-half, that of the water 18° ; the thermometer, when placed in the pericardium of the fish, rose to 18° and one-half, which I repeated several times with the greatest care. The heat has likewise been observed to be greater in the bodies of other cartilaginous fishes. Perrins (Nicholson's Journal, 1804,) has found 22° of heat in the stomach of the shark under $24^{\circ} 48'$ south latitude, while the water was at 19° and 5-9ths, and the air 20° and 4-9ths. Davy (Treviranus, S. 26.) found the blood which flowed from the great dorsal vein of a shark to be 22° and 2-9ths, and the temperature between the muscles of the back 22° and 4-9ths, while the sea was at 20° and 5-9ths, and the atmosphere 20° and 8-9ths.

Audirac (Rapports de la soc. philom. 1. p. 136.) informs us that fishes and amphibia, found in the hot water at Barrège, always exhibited a temperature lower than that of the water. Buniva (Mémoire concernant la Physiologie et la Pathologie des poissons, 4to, p. 12.) with great justice limits the importance of the observations on fishes which have been found in hot waters, but asserts, that he has found the temperature of carps to be three degrees higher than the (probably) cold water in which they were caught. He remarks, also, that fishes easily become insensible in cold, and that they are again re-animated by the careful application of warmth. Experiments by Krafft, Broussonnet, &c. the result of which shews that the temperature of fishes is higher than that of the water, may be found in Treviranus, S. 25.

Hunter's experiments (l. c. p. 117. seq. Exp. 29, 35, 39, 40, 41.) afford, among others, extremely deviating results;

in some, the warmth of the fishes (dead as well as living) was the same as that of the surrounding medium, in others, it differed from it. He allowed the tails of some gold-fishes to freeze (p. 125.), by which they had suffered much, and died after some time. We are, however, rather doubtful, whether the experiments made by thawing, &c. have been altogether correct, for Pallas (M.) says, that the *Cyprinus Carassius* of the Siberian seas, which are frozen on the ground in winter, are again re-animated in the spring by the thawing of the ice; and relates an observation from Bell (*Voy. de Russie*, Vol. 1. p. 318.), who once found the gold-fish before his windows stiff and immoveable, having been frozen in the water, and saw nearly all of them recover from it.

Benj. Moseley (*On the Diseases of Tropical countries*) found the stomach of a cod-fish to be much colder than the water in which it was taken, and also colder than the other parts of the fish, so that he felt a great and painful numbness when he wrapt it about his hand. I am indebted for the following information from the *Voyage de Verdun de la Crenne*, Borda et Pingré (Paris, 1778, 4to, p. 236, 237.) to our distinguished Leop. v. Buch. In Newfoundland, in the end of March, 1772, a thermometer was inserted into the stomach of a living cod, which, after remaining in it during half an hour, was withdrawn, and shewed 5° and one-half, while another thermometer, which was kept in the open air, remained at 11° . At another time the thermometer placed in the stomach of a living cod, fell to 2° , while another dipped in the sea, remained at between 4 and 5° . These observations appear singular, as they remain insulated; but they will at some future period unite themselves in an unconstrained manner with the above.

The temperature of the amphibia differs but little from that of the external medium, but a difference certainly does exist. De la Roche (*l. c.* p. 292.) likewise found by his experiments, that the power of cold-blooded animals (frogs) in retaining a lower temperature in a high and moist medium was greater than that of warm-blooded animals. A rabbit, whose proper heat was 31° and one-half, remained an hour and forty minutes in a moist and warm temperature of 36° , by which the heat of the animal rose to 34° and one-half. A frog, on the contrary, after remaining one hour in the same place, exhibited 21° and one-fourth, and retained the same temperature after remaining half an hour longer. The heat of another frog, in a temperature of 37° and one-half, remained at 27° and one-half.

Hunter inserted a thermometer, which in the air was at 5° and 7-9ths, into the stomach of a frog, where it rose to 7° and 5-9ths; in an atmosphere heated by steam, the thermometer, in its stomach, rose to 14° and 2-9ths.—At an atmospheric temperature of 11° and 5-9ths, it rose in the stomach, and afterwards also in the rectum of a strong viper, to 16° . The same viper of 16° was placed in a cold medium of 9° and 7-9ths, when its heat sank to 2° and 2-9ths. Ten minutes after, when the fluid was at 8° and 4-9ths, the temperature of the viper fell to 1° and 1-3d, and after remaining ten minutes in a fluid at 5° and 1-3d, it sank to 4-9ths, and no lower; its tail froze, and it became very weak. A vigorous viper was brought into an atmosphere at 33° and 7-9ths, and at the expiration of seven minutes exhibited in the stomach and rectum 26° and 8-9ths, and rose no higher. The same experiment was performed on frogs with the same result.

According to J. Davy (*Treviranus*, S. 26.), the temperature of the blood which flowed from the carotid of a tortoise, was

26° and 2-9ths, while the thermometer in the air remained at 20° and 8-9ths.

When the temperature of the room was at 10° (at Rimini, in April), I examined with the greatest care two *Lacertæ maculatae* which I had then had a few days. When the thermometer was passed into their throat it rose to 12°, and in the cavity of the chest to 15°, but as they became weaker, it sank to 13 and 12°.

At Trieste, in April, when the atmosphere was at 13°, and the water 12°, I passed the bulb of the thermometer into the throat of a *Proteus anguinus*, when it rose to 15°, and afterwards sank to 14 and 13°.

184.

The great heat of many insects, when living together, is very generally known; and Réaumur (*Hist. Nat. des Insectes*. Ed. Svo, T. V. P. II. p. 360, sq.) has communicated many interesting observations on the subject, and has shewn how false the hypothesis of Maraldi, &c. is, viz. that this warmth is caused by external movements and frictions, as for instance, by the motion of the wings of bees. It is without doubt increased by motion, in the same way as the heat of our own bodies, but is just as little originated by it; for when they stand quiet beside one another, the heat is very considerable. But the question is not concerning a few degrees, as we would be induced to believe by Braun, for the thermometer, around the bulb of which the bees had assembled, arose to 31°. The great sensibility of bees, gadflies, &c. to cold, is also well known, as likewise their re-animation in warmth.

A young and very promising natural historian, C. Aug. Sigism. Schultze, has found 25 to 26° in the body of the *Cossus ligniperda* Fabr. and we may at a future period expect very interesting observations from him on this subject.

Juch found 5° in the midst of the bees of a very full hive when the temperature of the external air was -22° . At a temperature of 10° , the thermometer, when placed in a swarm of ants, rose to 16 and 17° . He considers that an increase of temperature evidently takes place with all insects, when many of them are together.

J. R. Rengger (*Physiologische Untersuchungen über die thierische Haushaltung der Insecten*. Tüb. 1817, 8vo, S. 40.) denies the peculiar warmth of insects, but yet asserts that where there are many together, a very great degree of warmth takes place; in a vessel, in which were many may-flies, the thermometer rose several degrees. Where can this heat reside but in the insects?

Rem. Braun (l. c. p. 428.) says, that insects produce a peculiar heat by collecting together in swarms: *congregata calorem quendam efficere possunt, qui tamen ad calorem internum referendus proprie non est*. No grounds can be seen for such an opinion, and I cannot conceive how Treviranus (p. 30.) could embrace so mechanical an explanation as that of Maraldi, unless he has confided too much in the opinions of Braun.

185.

Birds possess the greatest degree of internal heat, and Martine (l. c. p. 142.) found it, from his experiments on geese, ducks, fowls, partridges, and pigeons, to be from 31 and 5-9ths to 33° and one-third. The experiments performed by Braun (p. 426.) on the larger birds, afforded the same result, so that he found it to amount in them to somewhat above 30° ; but he found it to be higher in the smaller birds, and in some red-breasts, (*Rubecula*) it was something above 35° .

Pallas (M.) has made observations on a great variety of birds, the results of which were as follows: The lowest

temperature he observed among them was (on the 29th of July, 1769, a moderately warm day) in the *Ardea stellaris*, viz. 31° and 5-9ths; the highest temperature was observed in the smaller birds, but in none of them did it exceed 35° and 1-9th (111° F.).

He found that of the *Vultur barbatus* to be 33° and 5-9ths; of the *Falco ossifragus* 32 and 2-9ths; *Nisus* 33 and 7-9ths; *Ianarius* 34 and 3-9ths; *palumbarius* 34 and 5-9ths. That of the *F. Milvus*, with a gun-shot wound in the wing, 32; *F. Albicilla*, with the feet shattered, 31 and 5-9ths. In the *Strix passerina* 32 and 6-9ths. *Picus major* 31 and 5-9ths. *Merops Apiaster* 32. In seven specimens of the *Emberiza nivalis*, from 34 and 3-9ths, to 34 and 7-9ths. In two specimens of the *Loxia Pyrrhula*, when the external air was very cold, 33 and 7-9ths. In the *Fringilla arctica* 35 and 2-9ths; the same in the *F. brumalis*; in another, when the air was very cold, 33 and 5-9ths. *F. Carduelis* 34 and 3-9ths. *F. domestica*, a female, in a damp atmosphere, 33 and one-third. A male under similar circumstances, 34 and 2-9ths. A female, in a cool room, 35. *F. Linaria*, the male 35 and 2-9ths, the female 34 and 7-9ths. *F. Spinus* 34 and 5-9ths. *Parus major* 35 and 2-9ths. *Hirundo* *Lagopus id.* *Caprimulgus europæus* 34 and 7-9ths. An old and lively male *Tetrao Tetrix* 33 and 7-9ths. In two young birds, 33 and 8-9ths. In the *T. Lagopus*, 33 and 3-9ths. Among seven specimens of the *T. Perdix*, two were 34 and 8-9ths; one 34; three 33 and 7-9ths; one 33 and 4-9ths. The *Ardea stellaris* 31 and 5-9ths. *Scolopax Limosa* 33 and 7-9ths. *Tringa Vannellus* (wounded) 33 and 3-9ths. *T. Pugnax* 33 and 7-9ths. *Hæmatopus Ostralegus* 32 and 8-9ths. *Fulica atra* 32 and 4-9ths. *Colymbus auritus* 33 and 3-9ths. *Anser pulchricollis* (an *ruficollis*?) 33 and 3-9ths. *Anas acuta* 32 and 4-9ths; *A. Penelope* and *strepera* 32 and 8-9ths; *A. clypeata* 33 and 7-9ths. Two specimens of the *Pelecanus carbo* 32° and 8-9ths.

According to Braun (p. 432.), a sparrow died after remaining seven minutes in a temperature of 50° and 6-9ths; but he does not inform us what degree of heat the bird itself had then acquired. Birds which are accustomed to the cold, can bear it in a very high degree; and J. Ge. Gmelin (*Flora Sibirica*, T. 1. Petrop. 1747, 4to, Præf. p. LI.) relates, that magpies and sparrows in Jeniseik, fell down as if dead, at a degree of cold at which the mercury was frozen, but that they again recovered when brought into a moderately warm room, and that the natives considered this as a very rare occurrence. In the birds of warmer climates it requires no very great degree of cold to produce asphyxia.

186.

Those animals which belong to the class of Mammalia, particularly the smaller ones, approximate very nearly to birds in respect to their high temperature; but it is much more changeable in them, particularly in those fallen in asphyxia.

Martine places the temperature of dogs, cats, sheep, oxen, and pigs, at, from 30° and 2-9ths to 31° and 5-9ths.

Braun (l. c.) found that of the calf and pig to be 32° ; that of the goat, lamb, sheep, and cat, 30° and 8-9ths; dogs 30° and 4-9ths. The seal (*Phoca*), according to the same author (p. 428.), possesses a temperature of 31° and 5-9ths.

Hunter (p. 115.) found that the thermometer, placed in the rectum of a dog, rose to 30° and 4-9ths, in the right ventricle of the heart to 30° and 6-9ths, in the liver to 30° and 5-9ths, in the stomach to 30° and 6-9ths. In the rectum of an ox and a rabbit to 30° .—The usual heat of the dormouse, *Myoxus Muscardinus*, is determined by Hunter (p. 111—113.) at 21° and one-third; in the cold (when they became more lively) it rose to 27° and one-third, which is certainly too low. He found in the diaphragm of the common mouse 29° and 7-9ths, in the pelvis

28° and 7-9ths. On the Erinaceus, p. 112. he relates the observations of Surgeon Jenner. According to these, the heat in the pelvis of a torpid Erinaceus was 5° and 7-9ths, while the external temperature during the winter was 5° and 3-9ths, and that of the diaphragm 7° and 3-16ths. At an external temperature of—2° and 6-9ths, that observed in the abdomen of a torpid Erinaceus was—8-9ths. The same animal was exposed for two days to an atmosphere of—2° and 6-9ths, when the heat of the rectum amounted to 27° and 1-9th. In summer, when the atmosphere was at 20° and 4-9ths, the heat in the pelvis of the Erinaceus was 28°, and in the diaphragm 28° and 8-9ths.

Pallas (M. and Glir.) found from his experiments, that bats and squirrels possessed the greatest degree of warmth. In various specimens of the Vespertilio Noctula he found 31° and 1-9th, in the Pipistrellus from 32 and 4-9ths to 32° and 8-9ths. In a young wolf, in the hottest time of summer, only 28° and 4-9ths. In a Hermelin 32° and 2-9ths. In an Iltis 30° and 6-9ths. In a living hedge-hog (*Erinaceus*) 28° and 2-9ths; in one which was almost in a state of torpidity 12° and 4-9ths; in another completely torpid, 3° and 3-9ths. *Sorex moschatus* 29° and 3-9ths. A common squirrel 32° and 6-9ths. In the black variety of the *Lepus variabilis* 32° and 4-9ths; a mixture of this and the common hare 31° and 7-9ths: Two males of the *Lepus pusillus*, 32°. A female marmot (*Marmota Bobak*) 30° and 4-9ths; in another 31° and 1-9th. It varies exceedingly in the *Citillus*: in two he found 30° and 6-9ths; in two 30° and 2-9ths; in three 29° and 7-9ths; in one 24° and 8-9ths; in another 21° and 7-9ths; in another 20° and 8-9ths; but these two last had then suffered from the cold. In the hamster (*Cricetus*) 26° and 2-9ths; 26° and 6-9ths; 29° and 7-9ths. In the *Arctomys* Glis 28° and 6-9ths. In the *Mus œconomus* 28° and 8-9ths. One domestic mouse 30° and 8-9ths; in three 30° and

4-9ths; and in one 29° and 7-9ths. In a male Musk 31° and 1-9th.

De la Roche found the warmth of a few rabbits to be from 31 and 1-5th to 32° ; of guinea pigs (*Cavia cobaya*) from 30 and 2-5ths to 31° and 1-5th.

The heat of the *Cetacea* can only, of course, be ascertained when they are recently killed: but even then it appears to be very great. W. Scoresby (An account of the Arctic Regions, with a description of the northern Whale-fishery. Edinb. 1820, 8vo, Vol. 1. p. 477.) informs us, that the heat of a sea-unicorn (*Monodon Monoceros*), which had been killed half an hour, was 28° and 8-9ths, and that of a recently killed common whale (*Balæna Mysticetus*) 31° and 1-9th.

187.

Fahrenheit has indicated the temperature of the human subject at 96° of his scale, or 28° and 4-9ths of Réaum.; this however is rather too low. Martine (p. 174.) says, that the external temperature of the human body is 28° and 8-9ths, or a little higher; that of the urine 29° and 3-9ths, or something more, and concludes from this, that the internal temperature of a healthy person will scarcely exceed 29° and 7-9ths, or at most 30° and 8-9ths (100° F.). Braun, from the majority of his experiments, in which the bulb of the thermometer was held in the mouth, considers it to be from 28 and 8-9ths to 29° and 3-9ths, but considers it to be higher than this in the internal parts of the body, as he has observed the urine to be from about 4-9ths to 6-9ths higher. Hunter (p. 109.) found the heat existing deep in the urethra of a man, to be 28° and 8-9ths, and in the rectum of the same 29° and 5-9ths.

I am convinced with Martine, from my numerous experiments, that the human temperature is generally uniform; and

I have found, in Berlin as in Naples, in summer as well as in winter, in the hand as in the cavity of the mouth, the same degree of heat, viz. from 29° to 29° and a half, and in other healthy persons, I have never observed it to be greater. I have, however, observed the warmth in the mouth of young people to be greater than that of the hands, as in many people the warmth of the hand (not merely from their own feeling) is something lower.

Rem. I do not remember of having any where read of an observation on the animal heat of other races of mankind. It has, however, been occasionally asserted, that Negroes feel themselves something cooler in a hot atmosphere than Europeans.

188.

The heat of the human body varies but few degrees during the diseased state from that of the healthy subject; we must here, however, except the state of asphyxia.

Hunter (on the blood, P. 2. p. 144.), at an operation for hydrocele, found the temperature in the vaginal coat at 26° and 6-9ths; a little afterwards, just as inflammation had commenced, he found it at 29° and 6-9ths. The former, however, was too low, and shewed a diseased diminution of temperature; the latter is about the natural height of the same. The water evacuated from the abdomen of a patient affected with ascites, being the seventh time of performing the operation (id. p. 147.), exhibited a temperature of 30° and 6-9ths; twelve days after, when the operation was performed for the eighth time, it amounted to 32° . His experiments on animals shew likewise, that a very small increase of temperature takes place during the inflammatory condition.

F. Home (Medical Facts and Experiments. Lond. 1759, 8vo, p. 217—228.) has described the number of pulsations, and the degree of heat which existed at the different periods of

diseases, in different patients. He mentions that some of these, at the invasion of the cold stage of intermittent fever, exhibited 32° of heat, while during the perspiration and after it, the heat diminished to 30 and $6\text{-}9\text{ths}$, or 29° and $7\text{-}9\text{ths}$. The greatest heat which he observed in fever was 33° and $3\text{-}9\text{ths}$, which is certainly very high, and he observes that this heat was intolerable to the patient: vide 191. *Rem.* 1.

John Thompson (Lectures on Inflammation. Edinb. 1813, 8vo, p. 46.) considers that the heat of an inflamed part never exceeds that of the blood contained in the heart; the latter, in the healthy state, generally amounts to 30° and $6\text{-}9\text{ths}$, but in disease it frequently rises to 32° and $8\text{-}9\text{ths}$, or even 33° and $3\text{-}9\text{ths}$ (108° F.).

James Currie (On the action of cold and warm water) divided an artery, and observed the thermometer which he held in his hand sink, at first gradually and then rapidly, from 31° and $5\text{-}9\text{ths}$, down to 26° and $2\text{-}9\text{ths}$. He then felt himself cold, and sank in weakness, when he saw his assistant, the thermometer, which he still retained in his hand, fallen to 22° and $6\text{-}9\text{ths}$. I am acquainted with no other observations on the temperature of the body during syncope; I think, notwithstanding, that it must be lower than the above-mentioned statement.

189.

The sources of heat in living animals in general are to be sought for in the changes which take place in the constituent parts, as we are obliged to consider it as arising from these in inorganic bodies. From the peculiarities of this change, and the thereby predominating fluid, arises the proper warmth of the body. Thus, for example, many inorganic bodies, as we express ourselves, are better or worse conductors of heat; they take on a higher or lower degree of temperature, without,

however, evincing their own peculiar heat, when left to themselves, or when not brought in contact with others.

In the internal parts of the organic or living body, an extensive and constant re-action is every where kept up, so that the heat which arises thereby is observable, and must therefore assume a more evident character.

Rem. Thus we see in living bodies which are in a torpid state, or fallen in asphyxia, that the internal heat diminishes, or is entirely suspended, according to the intensity of the former. See the observations on the dormouse and Erinaceus, mentioned 186.

190.

The high degree of heat which exists in animals in general, arises chiefly from the changes which take place during the process of respiration. Thus we find the highest degree of heat in birds, and next to them in the smaller mammalia; then in the larger class and the human subject; and lastly, a very considerable degree of temperature exists in many insects. Of this circumstance no other explanation can be given than this, that during the extensive and full inspiration of birds and mammiferous animals, the blood undergoes such a change, that it excites warmth wherever it flows; and in like manner, certain changes must take place in insects, which favour the developement of heat, on account of the air, which penetrates even to their most minute parts. In cold-blooded animals, as they are denominated, respiration, and the separation and changes of substances, which are determined by the former, are very trifling.

The nervous system, on the contrary, in which some authors consider the heat as originating, is by no means calculated for this office. In animals, for instance, the heat does not at all exist in proportion to the power of the nervous system. If such were the case, man would be possessed of a higher temperature than any other animal, on account of the

greater developement of his nervous system; the mammalia would by far exceed the birds; these would differ but little from the amphibia; and insects, with respect to their heat, would be far inferior to the fish: none of which circumstances exist. The electric organ of fishes, which is so plentifully supplied with nerves, does not exhibit a greater degree of warmth, even during the electric shock, than the other parts of its body, which circumstance bears much against the opinion of Buntzen.

Rem. 1. It is no objection to this doctrine to say, that if respiration be the source of animal heat, the lungs must necessarily be warmer than any other part of the body. The heat of a part depends on the quantity of blood it contains; thus people who are affected with an internal hemorrhage, feel a sensation of warmth in the part, which arises from the greater flow of blood in the abdomen. A numbed finger, when cut, gives out no blood, as I have witnessed in the case of a friend, whose finger (as it is said) frequently died; but with the return of the blood the finger became red and warm, and then the blood flowed from the wound. It is not asserted that free caloric, as a substance, is disengaged in the lungs, but that, during respiration, the blood becomes capable of exciting heat. How this last happens, we know not, as we are unacquainted with all other ultimate causes; but we know that it does take place, and this is quite sufficient.

Rem. 2. Treviranus (S. 54.) refers to an intimation of Autenrieth, that the cetacea only breathe at long intervals, and yet possess a very considerable degree of heat. This idea has arisen from the water, which is repelled from the spout-holes, being so seldom seen, but which is in no such connexion with respiration as to be considered synchronous with it; it happens much less frequently. Autenrieth in the same place (in the Salzburger Zeitung, 1795, B. 3. S. 328.) also mentions an opinion, that whales, like other fishes, breathe the air which is in combination with the water, which is equally as erroneous as the former. This excellent natural historian, however, had certainly given up this opinion, for in his Physiology this circumstance is not mentioned. The former objection,

which was once considered as a very strong one, likewise falls to the ground.

Rem. 3. The objections which relate to people affected with the morbus cæruleus and pulmonary diseases, are also easily explained. Those affected with the former disease generally complain of cold, and a warm atmosphere is very agreeable to them ; and further, they are incapable of exercising great and long continued movements. Individual cases also, in which the temperature is regular, admit of no other conclusion, as the causes of the morbus cæruleus are so very various, and sometimes very temporarily affect the patient. In patients with inflammation of the lungs, or various other derangements of this organ, the respiration is generally confined, but then it is so much the more rapid, that very little can be suffered in point of heat. Thus many changes in respiration may take place in derangements of the heart and lungs, without the conditions being suspended on which animal heat depends. We will say more on this subject in the Special Physiology, under the doctrine of respiration, where the theories of the generation of heat during respiration are also recorded.

Rem. 4. Digestion and assimilation, and all changes of fluids in general, have some influence on the production of heat, or they excite the same, but only in a subordinate degree, which will also be discussed, together with the above-mentioned subjects, in Special Physiology. It is here sufficient to remark, that the assimilation and digestion of many cold-blooded animals are at least as great as those of the warm-blooded animals. The butter-fly, when in the insect state, which digests so much, is cold, while in the latter state, when all is employed in motion and generation, it possesses a very considerable degree of heat.

Rem. 5. The influence of the nervous system on the whole animal economy, on the circulation and respiration, is so great, that we cannot at all wonder how injuries of it may have the effect of destroying the temperature ; but that caloric does not arise from this source is, I think, sufficiently proved by the preceding observations. No more can be said here on this subject, than on the feeling of warmth dependant on the nerves, and I refer to the Special Physiology, as well under the doctrine of the nervous influence, as to that of respiration.

The regularity of the internal heat during an increase or diminution of the external temperature, depends partly on the uninterrupted action of the organs, by means of which the generation of caloric is effected; and partly by the individual coadjutory functions, which are produced in the system by these changes of external temperature.

The opinion which was formerly advanced by Boerhaave, viz. that man and the warm-blooded animals were incapable of enduring an external temperature which exceeded the internal heat of their own bodies, has been contradicted from so many sides, that it may be considered as for ever subverted. The temperature of many regions is greater than the animal heat at certain times. Adamson (*Histoire naturelle du Sénégal*. Paris, 1757, 4to, p. 53.) found the temperature of the atmosphere at Senegal, during the night, to be 26° , and in the day 32° , in August, (the hottest time of the year); a thermometer, with the bulb placed in the sand, exposed to the sun at the same place, in July, shewed 60° and one-third, (p. 130.) During his voyage to Senegal (p. 81.), the heat of the cabin at mid-day (in November) was from 40 to 45° , and at night from 30 to 32 degrees. Captain Tuckey, 1779, experienced a similar heat on the Red sea, viz. the thermometer at midnight was never under 27° and $5\text{-}9\text{ths}$, at sun-rise never under 32° , and at noon never below 35° and $5\text{-}9\text{ths}$.

Mankind can also bear an artificial heat, higher than the animal temperature, with great ease. In the bathing apartments on the lake Avignano, near Naples, the greatest heat at the time I visited them, in the month of July, was 35° , which caused me no uneasiness. Blagden, among various other English naturalists, who have experimented on this subject, suffered a temperature of 101° and $3\text{-}9\text{ths}$, Réaum., or 260° Fah., for a period of seven minutes, and a dog somewhat lower, viz. from 220 to 236° Fah., or from 80 to 90° and

6-9ths, Réaum. for half an hour. Tillet saw a young woman bear a still greater heat than the above, in an oven; and in later times we have seen persons every where exhibiting similar feats for money; but in these the air is renewed, or they place themselves with the face towards a small opening through which they breathe the fresh air, so that by this means it becomes more tolerable, and the attendants on vapour-baths, the workmen in glass-houses, &c. endure just as much.

The internal heat is generally a few degrees increased, when the person is for a long time exposed to a great heat. Thus, for example, Fred. Gregorius (*Diss. de sudationibus Rosicis*, Berol. 1819, 4to,) found, by the experiments he made on himself and some of his young friends, in the vapour-baths of this city, at a temperature of 40—50° Réaum., that their internal heat received an increase of, from 2 and one-half to 3° and one-half.

A relief and evident diminution of temperature is immediately experienced when the skin commences to perspire, as this evaporation cools the body. Thus Blagden found it in the great heat above-mentioned, and also Martin (179), Alexander (*Rem. 1.*) and daily experience confirms the truth of it. Currie (p. 215.) explains the reason why Negroes endure excessive heat so much more easily than Europeans, by attributing it to their lubricating perspiration, which is less easily dissipated, and always keeps the skin moist. The moist nose of the dog is, in like manner, always cold to the touch.

The operation of the affusion of cold water, &c. on diseases in which there exists an excessive dry heat, cannot in the chief point be explained in any other way. If the external heat be suddenly diminished ten or more degrees, still the original heat of the body would soon return, but by this means a perspiration comes on, particularly when applied for this object.

When a person exposes himself for a long time to an intense cold, the warmth of the skin is thereby diminished, but the internal heat is increased by means of the congestion of blood. When the evaporation from the body is diminished, less heat is at the same time abstracted, and this condition can be borne for a long period, particularly when the too great determination of blood internally is diminished by exercise, without which another dangerous circumstance might take place. Vide 188. on the increase of temperature in cold fevers.

In the lower animals we find a number of assistant means for preventing the injurious action of cold, as they are destitute of all those means which we employ to protect ourselves against its influence. Some of them forsake those countries which are too cold, or afford them no nourishment during the winter; others which remain behind, are protected by large coverings of fat, or the thick coverings of their skins; and a third falls into a state of torpidity, by which the necessity for nutriment ceases, and the circulation and respiration become so weak that they have been denied by many to exist, and indeed they do cease in some, so that the heat returns with that of the atmosphere.

Rem. 1. Mémoire sur les degrés extraordinaires de chaleur auxquels les Hommes et les Animaux sont capables de résister. Par. Tillet. Mém. de l'Ac. des sc. de Paris, 1764, p. 186—205.—The experiments of Fordyce, Banks, Solander, Dobson, and Blagden, are communicated in three essays in the Philos. Transact. of 1775. To admit, with the English authors, a peculiar power in men of diminishing the heat, is very superfluous, for the evaporation entirely solves this question, as Treviranus has very excellently explained it, with whom I agree in all that he advances against the idea of suppressing perspiration by means of steam. Every day's experience in the vapour-baths confirms the truth of his arguments.

Will. Alexander (Med. Essays and Exper.) has made some very good observations on the debilitating and cooling action of perspiration, but his thermometrical calculations are certainly inaccurate. Thus, he

speaks of a heat of 112° Fah. or 35° and 5-9ths, Réaum. during the continuance of a fever, and of the same heat after taking a diaphoretic ; and also of 113° Fah., which is scarcely credible.

Rem. 2. Blagden was too short a time exposed to the heat to be depended on, when he asserts, that he could bear it much better naked. The female whom I saw, put on a great many clothes before she entered the oven, and as there is no necessity for exercising any movements, but only to endure a great heat in a still posture, the clothes must certainly serve for a protection. Tillet (*Rem. 1.*) however, also covered up the birds which he subjected to experiment.

192.

A *luminous* or *phosphorescent* appearance exists in many invertebral animals during life, over the whole surface of their bodies, or on certain individual parts of it. In the vertebral animals a similar circumstance is not found to exist ; at most we can only enumerate with these the rare cases where the urine, and still rarer cases where the perspiration of mammiferous animals, and also of man, is found to be phosphorescent. The electric sparks, on the contrary, which have been observed in the skin of man, but more frequently on that of many animals, as, for example, of the cat, can with as little propriety be considered as phosphorescence, as the reflected light of their eyes.

Rem. 1. For particulars on the phosphorescence of the lower animals, I refer the reader to the excellent and numerous investigations of Placidus Heinrich (*Die Phosphoreszenz der Körper. Fünf Abhandlungen. Nürnberg. 1811—20, 4to. Dritte Abh. S. 356—424.*) and Treviranus (*Biologie, V. S. 84—116.*). A small work unknown to both deserves to be mentioned ; Dom. Viviani *Phosphorescentia maris quatuordecim lucentium animalium novis speciebus illustrata. Genua, 1815, 4to, Tabb.*—Further, I can, by my investigations, support the observation of Treviranus, viz. that the *Lampyris* has no peculiar organ of phosphorescence.

Rem. 2. Felix Azara (*Essais sur l'Histoire naturelle des Quadrupèdes de la province du Paraguay*. Paris, 1801, 8vo, T. I. p. 213.) informs us, that Pater Guerra has related of a *Mustela* (Yagonaré), that its urine is luminous, the moment it is evacuated. Langsdorf (*Reise*, II. S. 184.) relates the same thing on the authority of another ecclesiastic, who also assures us, that the urine of the *Mustela Putorius* retains in the dark the capability of producing phosphorescence for a long time, when it is kept in a glass.

Examples of the phosphorescence of human urine may be found in Treviranus (*Biologie*, IV. S. 604. V. S. 117.) and Heinrich (p. 384.). The latter adds, that it is only found in the urine of people of a certain age. In old people there is more phosphorus contained in the urine.

In the same place are communicated the examples of luminous perspiration recorded by Henckel and Hermstädt. On phosphorescence after death, see 204.

Rem. 3. Electric light will be the subject of 196.—The luminous appearance of the eyes, I consider, with Gruithuisen (*Beiträge*, S. 190—201.), to be merely reflected light, for I only observe it when the eyes are in a certain position where the light falls on them, and the head of the cat, when cut off from the body, shines as it does during life. Pallas (*Zoographia Rosso-Asiatica*, T. I. p. 14.) considers it as the action of the nervous substance which is no where else visible; this, however, is contradicted by the above-mentioned observation. I must differ from Treviranus (B. 5. S. 121.) in suspecting that it originates from the pigment of the eye; for the ground of the eyes of cats, and all other animals whose eyes are luminous, is destitute of the pigment, and are actually reflectent; and also Sachs, whose eyes were luminous, was an Albino, and of course destitute of the pigment. And had all those of whom similar circumstances are related, not been deprived of the pigment, they would not have had these facts to record. Heinrich (p. 387.) attributes the luminous appearance of the eyes of cats, partly to reflection, and partly also to phosphorescence; as it is not always in the same degree, but is sometimes excited voluntarily, and sometimes by rage, in the same way as it is only excited in man during disease, and an excited state of the nervous system. But this also appears to me to be no weighty objection, as by these they must be modified (by congestion, tension), and can

reflect better or worse according to the various emotions of the mind, as the eye in general is so changeable, sometimes heavy and dull, at others sparkling and full of life.

193.

As there are certain animals which are phosphorescent, there are likewise others which are particularly endowed with *electric* influence. To these belong, before all others, a species of very many varieties, viz. the Torpedo, two of which,—the *T. marmorata* and *T. ocellata*, are found in the south European seas, while many others present in various parts of the world, and an immense variety has belonged to a former age. These are *Rhinobatus electricus*; *Tetrodon electricus*; the electric-eel, *Gymnotus electricus*; *Trichiurus electricus*; *Silurus electricus*; and perhaps a large American Mantis.

Rem. 1. Risso (*Ichthyologie de Nice*, p. 18—22.) mentions four species of the Torpedo, viz. *T. vulgaris*, with five spots on the eyes; *T. unimaculata*, with one spot; *T. marmorata*, with many small irregular dark spots; and *T. galvani*, unspotted, and has given figures of the last three. But the *T. unimaculata* is nothing more than a variety of the *T. vulgaris*, improperly so called, which I would rather, with the Italians, denominate *T. ocellata*; and the *T. galvani* is only a variety of the *T. marmorata*. The last is the most common species, which I have found both in the Adriatic and Mediterranean seas; the *T. ocellata*, on the contrary, has never been seen in the Adriatic. Rondelet mentions also four species; his second is the *T. ocellata*, without the bright spotted border; his first, third, and fourth, are mentioned by Risso after him.

Patrick Russell (*Description and figure of two hundred fishes collected at Vizagapatam on the coast of Coromandel*. Lond. 1803, fol. p. 1, 2. Tab. 1, 2.) mentions two new species, *Temeree* and *Nalla Temeree*, which Shaw (*General Zoology*, Vol. V. P. 2. p. 316.) calls, *Raja maculata* and *bicolor*. Russell mentions nothing of their electric pro-

perty, and had not indeed seen them alive. In Schneider's *Systema Ichthyologiæ Blochii* (Berol. 1801, 8vo, p. 359.), we find a *Raja Timlei* of Tranquebar mentioned, which perhaps is the same as the first species of Russell; he mentions also a *R. dipterygia* from Tranquebar.—The *Torpedo sinus persici*, which is described and figured in Kaempfer's excellent work (*Amœnitates exoticæ*, Fasc. 3. p. 509—515.), appears likewise to be different.

The same may be said of the *Torpedo capensis*, Schneid. p. 360. John T. Todd (*Philos. Transact.* 1816, P. 1. p. 120—126. Some obss. and exp. made on the *Torpedo* of the Cape of Good Hope,) thinks that the *Torpedo* of the Cape is not different from that which is found in Europe, but says himself that it is smaller, and that the tubes are larger in the organ which is of itself less; and perhaps there are different species here, according to his own descriptions.

The American species which I have seen, appears also different.

The huge specimen figured in the large *Ittiolitologia Veronese* (Verona, 1796, fol. p. 251. T. 61.) by Serafino Volta, as the *Raja Torpedo*, which was found among the petrifications of Monte Bolca, is certainly very different from all the living species that have yet been discovered.

Rem. 2. The *Rhinobatus electricus* (Schneider, l. c. p. 356. n. 3.) is described and figured by Marcgrav (*Hist. Brasil*, p. 152.) under the name of *Puraque*. He says of it: “*Caput recens lucet noctu. Caro ejus non comeditur, sed si comedatur, asserunt piscatores, per tres horas semifatuos reddi homines, dein sponte ad se redire. Unius attactus crepitum articulorum manus et brachii causat, qui tamen statim desinit, et si in medio tangatur, artuum tremorem efficit. Capitur in Bibiribi fluvio.*” But according to the species it is without doubt a sea-fish.

Rem. 3. We know nothing of the *Tetrodon electricus*, of which a few specimens were found by Will. Paterson (*Philos. Transact.* 1786, P. 2. p. 382, 3. Tab. 13.) between the coral banks of the island Johanna, in the Indian ocean (12° 13' south. lat.), further, than that he and his companions received electric shocks from it, which appeared to be very considerable for a fish seven inches in length.

Rem. 4. The *Gymnotus electricus*, found in various rivers of South America, is, next to the *Torpedo*, the most familiar to us: vide 194.

Rem. 5. Of the *Trichiurus electricus*, we have only the imperfect description of J. Nieuhoff (*Zee en Lant Reize door West-en Ostindien*. Amst. 1682, fol. p. 270.), viz. that those who killed it were seized with a slight numbness. This is perhaps the same fish which Marcgrav, p. 161., describes under the name of *Mucu*, without, however, mentioning that it possessed any particular electric power.

Rem. 6. The *Silurus electricus*, or the *Malapterurus electricus* of Lacépède, is found in various rivers of Africa: vide 194.

Rem. 7. Bloch quotes a passage on the subject of electric fishes from the *Journal des sçavans* (1667, p. 91. ed. 4.), in which the *Physalia* is the subject of the essay, which does not belong to this race.

Rem. 8. Marcgrav, p. 251., says of a large *Mantis*:—*si hominem feriat, aliquem tremorem excitat in toto corpore, non facile autem alicui nocet, nisi quis manibus premat aut pedibus*. Frezier (*Relation du voyage de la mer du sud*. Amst. 1717, 8vo, P. 1. p. 214.) refers partly to this passage of Marcgrav, where the animal is represented by a plate, but speaks further of a small bladder situated in its body, and containing a fluid which he calls *Polpo*, and of which the inhabitants of Chili relate, that it benumbs the hand in an instant if it be applied to it uncovered. As he could find no antennæ in this animal as represented in the figure of Marcgrav, we might almost refer it to Klug's new species *Proscopia* (*Horæ berlinenses*. Bonn. 1820, fol. p. 15. sq.); but we evidently also find here the commencement of a transition from this insect to the polypus, which has been carefully propagated by Vidaure (*Geogr. natürl. und bürgerl. Geschichte des Königreichs Chile*. A. d. Ital. Hamb. 1782, 8vo, S. 63.) under the name of *Polpo*, and by Molina (*Storia naturale del Chili*. Ed. 2. p. 175.) under that of *Pulpo*, *Sepia Hexapus*; they describe it sometimes as an articulated body with six feet, at others as a polypus; they may, however, be considered as only copying from Frezier.

Rem. 9. Treviranus (*Biol. V. S. 144.*) mentions a specimen of the *Alcyonium Bursa*, to be found in the museum of Bremen, together with the manuscript observations of its former possessor; he says, that he has experienced an electric shock by disturbing the living zoophyte. But

it is very much to be suspected that the sensation he experienced arose from the mere contact with the cold object, as it is very probable that the zoophyte in question belongs to the vegetable kingdom.

194.

The *electric organs*, or, as they were formerly denominated, the *corpora falcata*, of the *Torpedo marmorata* and *ocellata*, are very easily known. On each side near the scull and gill, there is placed a body, which consists of many hundred prisms of from three to six sides, which stand perpendicular to, and close on, each other, extended from the skin below to the skin above, and bound firmly to it by cellular membrane, which are as so many voltaic columns. If we examine these in a specimen which is fresh, or preserved in spirit of wine, we observe each prism to consist of a tube surrounded with nerves and vessels, with their membranous walls, in which are found a great number (according to Hunter, 150) of thin plates or partitions difficult to separate, and arranged in horizontal layers on one another, with an albuminous fluid contained between each. When the columns are, on the contrary, quickly dried, the plates are not only seen more distinctly, but may be easily separated, and do not appear to form any tubes, while the surrounding cellular membrane alone preserves this appearance. Todd (p. 121.) considers the tubes as quite cylindrical, and that they have the appearance of corners merely as the consequence of the appending cellular membrane; but this is evidently wrong. Girardi describes them also as six-cornered generally, and now and then five and four-cornered. Three large nerves are given off on both sides to these organs, dividing equally into parts, so that they penetrate the tubes horizontally, and are entwined around them in such a manner that each plate seems to receive its nerves as its vessels. In many of the prisms, con-

nexions between their nerves may also be pointed out. All the three principal branches, before they reach the electric organs, give off smaller branches to the gills; the first of these is certainly to be considered as the fifth pair of nerves (*par quintum s. divisum*), the second and third as the tenth (*par vagum*), as is done by Cuvier (Leçons, T. V. p. 268.), except that he considers three branches as given off from the vagus to the organ, without taking observation of their earlier connexion.

If the electric organs of the Torpedo cannot be denied to be batteries of voltaic columns, then those of the Gymnotus electricus, on the contrary, must be considered as a very numerously compounded trough. On each side there is a larger superior organ, and an inferior smaller one. Each commences immediately behind the head, under the large muscles of the back, where it is obtusely round, and runs along towards the point of the tail; towards the spine it is plane or somewhat concave, externally it is convex; superiorly it runs into a sharp border, inferiorly it diminishes, and is strongest in the middle. It consists of horizontal membranes, situated about the third part of a line from each other, and extending along the whole length; between these we find perpendicular laminae arranged from within outwards, bound firmly to them, and dividing them into right-angles; they are very closely arranged on one another, and contain water in the small cavities which are formed by this arrangement of the laminae. Under this larger organ there lies a smaller one exactly similar to it, which is still more minutely divided, and which, where it borders on the other, is only separated from it by a horizontal wall, while at the sides of the fish, on the contrary, the organs diverge in order to afford space for the interposition of muscles. In the specimen which I have before me, the intercostals on each side, 224 in number, pass off at the inside of the organs; they are then immediately divided, and pass over all parts of them, so that their branches spread

from before posteriorly, and inosculate with each other; but the fine ends of the intercostal nerves, under the smaller organ, pass to the skin, and here they form fine and uninterrupted net-works, which cover the skin through its whole extent. A large twig, which is given off from the third branch of the fifth pair, and is increased by a smaller one from the par vagum, passes posteriorly near to, and parallel with, the spine, from before quite down to the tail, passing directly over the intercostals (crossing them at right-angles), and nowhere uniting with them, but distributing its twigs to the muscles of the back. This is the nerve which Hunter considered as the par vagum, and which Fahlberg improperly denominated the par electricum.

The organs of the *Torpedo* and *Gymnotus electricus* agree in this, that they exhibit tubes or foramina, with which their laminae form right-angles, and the intermediate spaces of which are filled with a fluid. They differ, however, in respect to the breadth and length of their organs, which, in the *Gymnotus electricus*, are likewise firmly bound together at every part, while the prisms of the *Torpedo*, and their transverse laminae, have a loose connexion; the supply of nerves is very great in both, but in the *Torpedo* it is porportionably greater.

Rem. 1. Stef. Lorenzini, *Osservazioni intorno alle Torpedini*. Firenze, 1678, 4to, tabb. contains very little matter of use to us.—John Hunter, on the contrary, is entitled to much commendation, for having so admirably described the anatomy of the *Torpedo*, as well as that of the *Gymnotus electricus*, except in very few points; his figures, however, are deficient. *Anatomical obss. on the Torpedo*. *Philos. Transact.* 1773, P. 2. p. 481—489. Tab. 20. *An account of the Gymnotus electricus*. *ib.* 1775, P. 2. p. 395—407. Tabb. 3.—Mich. Girardi, *Saggio di osservazioni anatomiche intorno agli organi elettrici della Torpedine*. *Memorie di Matematica e Fisica della societa italiana*. T. 3. p. 553—570. Tab. He calls the nerves electric nerves, without comparing them with those

of the human body. Samuel Fahlberg, *Beskrifning öfver electriske Alen, Gymn. electricus*. K. Vet. Ac. Nya, Handl. 1801, P. 2. p. 122—156. Little to the point.

Through the kindness of Lichtenstein, I have had an opportunity of investigating a specimen of the *Gymnotus* of the same size as Hunter's, and will give a set of accurate figures of this, and likewise of the *Torpedo* which I dissected, in the writings of our academy. Luca Frioli, an intelligent physician of Rimini, shewed me, when I was there in 1817, his method of hardening quickly the electric organs of the *Torpedo*, by which the columns appear to be constituted merely by the transverse laminæ, without side partitions, on account of which they were called tubes. I have never been able to represent the plates so beautifully by spirit of wine; he retains to himself, however, the office of making his method known to the world; Girardi macerated the columns in red wine.

Rem. 2. Of the *Silurus electricus* (*Malapterurus Lacépède*) we have no satisfactory information; but the travellers of our academy, D. Ehrenberg and D. Hemprich, who are now in Egypt, will, no doubt with their accustomed zeal, make the necessary enquiry for clearing up this interesting subject.

Adanson was the first who observed it in the river Senegal, and described it, *poisson trembleur* (p. 134.), but very superficially. Forskähl (*Descriptiones animalium, quæ itinere orientali observavit*. Havn. 1775, 4to, p. 15. n. 14.) found it in the Nile, and confounded it (on the journey, without a remedy) with the *Torpedo*. Broussonnet (*Mémoire sur le trembleur, espèce peu connue de poisson électrique. Mém de l'Ac. des sc. de Paris pour 1782, p. 692—98. Tab. 17.*) described it as a *silurus* externally; and adds the following description of its electric organ: “Forskähl dit, que ses effets électriques n'étoient sensibles que vers la queue; la peau qui recouvre cette partie nous a paru beaucoup plus épaisse que la celle du reste du corps et nous y avons bien distingué un tissu particulier, blanchâtre et fibreux, que nous avons pris pour les batteries du poisson.”

E. Geoffroy (*Mémoire sur l'anatomie comparée des organes électriques de la Raie torpille, du Gymnotus engourdissant et du Silure trembleur. Annales du Musée d'Hist. Nat. T. 1. p. 392—407. Tab. 26. fig. 4.*)

considers the organ, on the contrary, as lying under the entire skin of the fish, and as giving off transverse fibres, to which the nerve of the lateral line, the vagus, is distributed. But the figure which he gives of it is so roughly done, that we can perceive no nerves in it. In the large work on Egypt (Zoologie. Poissons. Tab. 12. *Malapt. electricus*), the figure representing the electric organ is equally as deficient, and is no where different from that above-mentioned. Cuvier (*Regne Animal*, T. 2. p. 208.) says; “Il paroît que la siége de cette faculté électrique est un tissu particulier situé entre la peau et les muscles, et qui présente l'apparence d'un tissu cellulaire grasseux (?) abondamment pourvu de nerfs.” Tuckey (*Relation d'une expedition au Zaire*. T. 2. p. 261.) mentions this fish very slightly.

I perceive that the vagus, in the *Silurus Glanis*, passes to the lateral line, but there is no net-work of filaments observable beneath the skin.

195.

By means of these organs, the fish in question can produce electric shocks of greater or less intensity, according to their kind, or the degree of vigour which they possess. The *Gymnotus electricus* enjoys this power to the greatest extent, and next to it the *Torpedo*.

That they are true electric shocks, is shewn by the perfect similarity of all their effects, particularly by their capability of being conducted and insulated; the electric sparks which had formerly never been observed, have been lately discovered in the electric fish; and the sensation experienced by the shocks received from these animals completely coincide, at least according to my experience on the *Torpedo*, with the sensation produced by galvanism.

Steffens (*Schriften*, 2. S. 110—136. Ueber die electrischen Fische) compares all these known appearances together, and endeavours to prove an analogy between these electric organs and the muscles, an attempt which can never succeed.

Rem. 1. Besides the authors already mentioned, the following may be referred to on this subject.

J. Walsh, Of the electric Property of the Torpedo. Philos. Tr. 1773, p. 461—480.—Laz. Spallanzani in the Journal de Phys. 1783. T. 23. p. 218—220. The same of 1786. T. 28. p. 261—267. In two fœtal Torpedos which he took from the uterus, he found that the power of producing slight electric shocks existed at this early period.—Gay Lussac and Humboldt, Expériences sur la Torpille. Ann. de Chimie, T. 56. p. 15—23.—P. Configliachi, L'identita del fluido elettrico col cosi detto galvanico. Pavia, 1814, 4to.

Hugh Williamson, Exp. and obss. on the *Gymnotus electricus*. Philos. Tr. 1775, p. 94—101.—Alex. Garden, An account of the *Gymn. electr.* ib. p. 102—110.—Alex. v. Humboldt, Obss. sur l'Anguille électrique in his Recueil d'obss. de Zoologie et d'Anatomie comparée. Vol. I. Paris, 1811, 4to, p. 49—92. His Travels, P. 3. p. 295—314.—F. Ludw. Guisan, Comm. de *Gymnoto electrico*. Tubing. 1819, 4to.

Rem. 2. This power is so great in the *Gymnotus electricus*, that according to Humboldt, two of them by their electric shocks could kill a horse.—I generally felt the shocks of the *Torpedo marmorata* to extend only as far up as the wrist, and very seldom as far as the elbow joint. Todd says, that they are never felt beyond the shoulder joint, generally not above the bend of the elbow.

It appeared to me as if the shock were stronger when I did not hold it alone (by the back and belly at the same time), but when my assistant laid hold of one side, and I the other, in the situation of the organs above and beneath. Perhaps this happens on account of the greater inequality which then exists, and consequently the re-action is stronger. Humboldt observed that when the *Gymnotus electricus* was held by two persons, the shock was frequently only experienced by one; but then they must have seized it at different parts.

That the muscles of electric fishes act during the discharge of their organs may easily be conceived, as they are then inclined to operate, or to rid themselves of it; but these motions have nothing further in common with the electric shocks, and also act without these taking place.

Rem. 3. The idea which was formerly introduced by G. G. Schilling (De Leprea. L. B. 1778, 8vo, p. 43.), viz. that the *Gymnotus electricus* operates magnetically, and attracts the filings of steel, has already been

frequently contradicted, but is now brought forward again by later physiologists.

196.

Examples of true electric appearances in animals, in whom such organs are wanting, as likewise in man, can at most only be considered as very rare occurrences.

To these belong, in the first place, all those cases in which, by rubbing the skin of man or the lower animals in the dark, electric sparks become visible ; and secondly, the evident sensation of electric shocks which are felt in the arm or in other parts of the body, viz. at the exit of the second branch of the fifth pair of nerves from the infra-orbital foramen ; they happen without any evident cause, or by sudden (too quick) movements of the neck.

The prominent feature in the action of the electric organs of these fishes consists solely in the immense preponderance of their nervous apparatus, to which we and other animals can oppose nothing equal. Consequently, one *Gymnotus electricus* experiences no effects from the contact of another, because there is no change of equilibrium produced by the contact of two bodies which are equally supplied with the same electric power ; but a greater power than is possessed by the animal itself, viz. that of a galvanic battery, easily acts upon it. Thus the action of these organs on us varies according to the degree of their intensity, for they possess no specific property. Who knows what other animals may suffer from us, and whether a sort of numbness is not produced in them, when, for instance, we stroke their spine with our hand, which is so plentifully supplied with nerves ; at least something of the kind appears now and then to take place, when they are thereby suddenly made to stand still. That the will is connected with the production of these shocks, may be as easily comprehended as that volition is at all connected with many

of the actions of the nerves of our body, which, however, will be treated of in the special part of the work. This much is certain, that these electric organs would not only be useless, but also, by exhausting them, injurious, to the animals, were they not subservient to their will, of which they may, notwithstanding, be deprived, by strong or too long continued excitement, in the same way as our voluntary organs, when under similar circumstances, produce involuntary actions.

Rem. 1. Examples where an electric crackling and sparkling was observed in the dark, in men, while changing their shirts, stockings, combing their hair, &c., are found in very many authors. I will merely mention the following: Ez. de Castro, *Ignis Lambens*. Verona, 1642, 8vo. Thom. Bartholin, *De luce hominum et brutorum libri tres*. Hafn. 1669, 8vo.

These appearances are much more frequent in animals, particularly in cats, when they are stroked on the back in the dark, in horses, when they are combed, &c. I myself witnessed on the evening in which this was written, a strong sparkling, accompanied with a crackling noise, in a grey rabbit, when the hair of the back was stroked towards the head.

This sparkling eminently distinguishes itself from the phosphorescence of dead bodies, and also from that of the glow-worm; as the latter is milder and uniform, and unaccompanied by a crackling, while in the former, the fiery sparks appear and vanish again in an instant.

Rem. 2. I have frequently observed these shocks in myself, particularly in my youth, which are evidently the same as those experienced from galvanism. I have felt it twice in the neck, where it is no doubt the same as what Pouteau considers as a displacement of the muscles of the neck, and which is soon replaced by friction; but it quickly disappears of itself without leaving any trace; thus also, during a feeling of electric twitching at the foramen infra-orbitale, the part is involuntarily rubbed, as I have observed in a person who was greatly affected with *tic douloureux*. Shuddering is an appearance which is something analogous with this, and which I was also much affected with in my youth; it produced a sen-

sation as if some person unsuspected had ruffled my hair. Electricity acted very beneficially on me. Excepting this, I was quite healthy.

Rem. 3. We might with great propriety class with these all nervous effects on muscles and other organs, as they probably all arise from electrico-chemical processes. We will discuss these in the following part.

197.

To the above-mentioned phenomena belong all those cases where a spontaneous combustion is produced in certain persons, which consumes them.

When we consider the cases which are as yet known, we find, that with two exceptions, they were all females, who were for the most part old, very fat, and addicted to the excessive use of spirits; in both the males, there were but few of the parts of their bodies burnt, while in the women nearly the whole of the body was consumed and burnt to ashes; in these cases an oily soot covered the walls and the furniture, which was little, or not at all damaged, and a burnt, disagreeable smell filled the apartments.

The bodies of such persons have been considered sometimes as impregnated with spirits, and that they consequently have become combustible; but it may be objected to this in the first place, that those who received their death in this way were not all dram-drinkers; and in the second place, the idea is completely erroneous that the body can ever be so impregnated with spirits as to become combustible, for the fire has been seen even issuing from the mouths of great drunkards, without producing any combustion of the body.

In the only instance on record where a person was partially seized with fire at the arm, so that having drawn people to his assistance by his cries, he was enabled to relate to them how the accident happened;—he had felt a pain suddenly seize the arm, like the blow from a club, and observed at the same

time a spark of fire which consumed his shirt to ashes. Here there can be no question but it was an electric action, and it is highly probable that such an one is always necessary to its production ; the possibility therefore of its origin in the human body must certainly be admitted, notwithstanding that the contrary is contended by Treviranus. Vide 196. *Rem.* 2.

If at the same time phosphuretted hydrogen gas, or something similar to it, were produced in the human body, then the explosion would be explained ; but still the destruction of the body, and its extremely rapid combustion, must always appear very singular, as it would otherwise require a remarkable quantity of combustible matter, and a certain length of time, to reduce a fresh human body to this state. Perhaps also in these cases the substance of the muscles, which are very difficult to consume, was converted into adipocire ; the bones likewise of old people are scanty in earth, and rich in oil ; and perhaps a great many other circumstances of the kind must happen together, in order to render such an accident possible.

Rem. In the following works are contained all those cases of spontaneous combustion which are yet known : Pierre Aimé Lair, *Essai sur les combustions humaines produites par un long abus des liqueurs spirituelles*. Paris, 1800, 12mo. Versuch über das Verbrennen menschl. Körper, &c. Uebers. von C. W. Ritter. Hamb. 1801, 8vo. As a supplement to this : Ueber Selbstentzündungen in organisirten und leblosen Körpern. Herausgeg. von C. W. Ritter, Hamb. 1804, 8vo.—J. Hnr. Kopp, *Ausführliche Darstellung und Untersuchung der Selbstverbrennungen des menschlichen Körpers*. Frkft. a. M. 1811, 8vo.—Treviranus's *Biologie*. V. S. 131—139.

CHAPTER V.

OF DECOMPOSITION IN THE HUMAN SUBJECT AFTER DEATH.

198.

With the life of organic bodies all the chemical processes cease which are concerned in its support, and their remains either do not act at all on one another, viz. when excluded from the action of the atmosphere, 206., or when exposed to it, they, for the most part, reciprocally favour their decomposition.

199.

The circumstances however, by which organic bodies are reduced into their constituents, have, on account of the peculiarity of the matter with which they are concerned (167.), something very remarkable, and altogether different from any thing observed to take place in the inorganic kingdom, which is generally comprehended under the name of fermentation (*fermentatio*), and putrefaction (*putredo, putrescentia*).

200.

The organic kingdoms are considered to vary in so far as the vinous and acetous fermentations are only ascribable to vegetables and a few animal fluids; so that the vegetable bodies must, in the first place, pass through the above-mentioned processes before putrefaction takes place, while in animal bodies putrefaction commences in the first instance. This,

however, is certainly not the case, for the human corpse can exhibit all the changes which are common to other organic substances.

When, for instance, healthy, strong persons die suddenly a violent death, which has not arisen from poison, or in any way connected with a loss of blood, and their bodies are dissected in mild weather, we invariably observe that after a short time, it gives off a disagreeable sweet smell, which after some time becomes acetous ; this state continues for a few days, and is then succeeded by putrefaction.

Rem. During the eleven winters which I have passed at this anatomical theatre, I have frequently observed this circumstance. The first time I observed it, was in the herculean body of a man who had been drowned accidentally in the presence of many witnesses, and consequently required no legal examination ; I therefore chose him for my demonstrations, and had not only to endure this very disagreeable smell, but as is always the case in these subjects, found the muscles so loose and soft, that even the strongest of them were so easily torn, that they scarcely sufficed for the demonstration : on which account I always avoided them for the future. I am rather astonished that I have nowhere found this sweet and acetous fermentation of human bodies mentioned. It is very probable indeed that it can only be observed in anatomical theatres under favourable circumstances. Of the probable length of these periods of fermentation under various circumstances, I cannot give a more correct idea, but I shall be more attentive to this circumstance in future, and I trust that others will also be observant on a subject which is certainly worth the investigation.

201.

The appearance of stiffness (*Rigor*) which takes place after death, and precedes the process of putrefaction, is seldom overlooked in the human subject, but more frequently in the lower animals. According to the excellent investigations of Nysten on this subject, stiffness takes place in all

vertebral animals, and of the invertebral animals in all those which have an evident muscular system, for it is peculiarly on the muscles that this stiffness depends. The degree and duration of this state in man, is in direct proportion to the strength of the muscles. The more these are exhausted, as for example, after chronic diseases, the more quickly does this state of rigidity commence; and so much the later on the contrary, the stronger the muscles were at the time of death, viz. after acute diseases and violent death. When the stiffness commences later, then it is stronger, and continues longer; that which commences early, soon ceases. In the mammalia and birds, it commences at the moment when the animal heat appears to be extinguished, and when the artificial stimuli appear not at all, or imperceptibly, to affect the muscular contractions.

It always commences in the human subject at the trunk and neck, it then seizes the superior, and lastly the inferior extremities, so that the latter appear flexible while the former are rigid. The rigidity ceases also in the same way, at first in the trunk and neck, then in the superior, and lastly in the inferior extremities, which frequently remain stiff for many hours after the other parts are completely relaxed.

Rem. 1. I agree in the observations of Nysten (*Recherches*, p. 384—420.), that the seat of rigidity is in the muscles, for, if we cut through the muscles on which such a contraction would depend during life, we see that it immediately ceases. I cannot however coincide with him in considering it as the remains of muscular power, for we can throughout see no cause, why the power of strong muscles should be longer in returning, or why it is renewed according to this determinate course from the trunk; I consider it on the contrary, to be the consequence of a chemical process, which from the termination of nervous influence (perhaps thereby) develops itself, as in this there is nothing objectionable. This seems also to be shewn by the following experiment: I observed in a dead subject, that the neck was stiff, and drawn obliquely to the left

side; I divided the sterno-cleido-mastoideus muscle of the same side through, the neck became immediately moveable, but both ends of the muscles, throughout their whole extent, remained harder than usual for some time: this was not the case during life, for they were weak and relaxed; I cannot, therefore, consider it as the remains of a vital power. Neither can I conceive why Nysten distinguishes this rigidity from the so named roideur convulsive, or stiffness, which so frequently follows the convulsions preceding death. When the muscles remain stiff or rigid, in death preceded by Trismus or Tetanus, what else is it but the fibres excited to contraction by a chemical operation; how could this vital power remain in the body a whole day? Nysten has also subverted his own opinion, when he says (p. 419.), that neither Paralysis nor the destruction of the spinal marrow, are able to prohibit this rigidity from appearing to its full extent. This completely excludes the possibility of it being the remains of life. I find also no difficulty in explaining a case once observed by him (p. 387.), where the inferior became sooner flexible than the superior extremities. Why the rigidity was so quick, was probably a chemical phenomenon in the mammiferous animals and birds, arising from the cold, as they were the sound carcasses of animals on which he made his observations. The cold does not so easily act on us on account of our various modes of living.

Nysten is certainly very right in suspecting the accuracy of Haller's observation (El. Phy. VIII. P. 2. p. 124.), who says, that he could perceive no stiffness in the corpse of his son. In such cases a father can be no accurate observer.

Rem. 2. I think that it is certainly worth the trouble to investigate this subject more closely, particularly as we have a sure sign of death connected with the termination of the re-action against galvanic stimuli. The torpidity of living bodies from cold, can, as Nysten remarks, be confounded with it by no one who attends to the circumstances.

The commencement and degree of the putrid fermentation or putrefaction in the human subject, is regulated both by

the state of the body, previous to death, and according to the external circumstances to which the body is exposed after death, so that on this account many varieties arise.

Rem. The authors who have written on putrefaction were, for the most part, actuated by particular views—to find out whether putrefaction had already existed in the living body, or whether an approach was made towards it (on which subject see the following book), or by what means putrefaction might be avoided, &c. The minute investigation of the human body, and those of all other animals, is particularly wanting.

Abr. van Stipriaan Luiscius, Abhandlung zur Beantwortung der Frage, welches sind die Ursachen der Fäulniss in vegetabilischen und thierischen Substanzen, und welches sind die Erscheinungen und Wirkungen, die durch sie in ihnen erzeugt werden. A. d. Holl. Marburg, 1800, 8vo.

Ueber die Fäulniss lebender und todter thierischer Körper, über Faulkrankheiten und faulnisswidrige Mittel. Hildburgh. 1795, 8vo,

Adam Seybert, Abhandlung über die Fäulniss des Bluts im lebenden thierischen Körper. A. d. Engl. Berl. u. Lpz. 1816, 8vo.

Essai pour servir à l'histoire de la putréfaction. Paris, 1766, 8vo. 48 and 578 are only experiments made with antiseptic medicines.

203.

When persons who have been generally healthy, die from old age, their bodies, when under favourable circumstances, retain for a long time the appearance of sleep ; the warmth is very gradually extinguished, and putrefaction commences late, and proceeds slowly forward. The bodies of those persons also, who die from a general consumption, a loss of blood, and similar causes, and from long exhaustion, remain a long time before they are seized with putrefaction. On the contrary, when people are killed by quick acting poisons, particularly by those which are denominated septic, by lightning, or by the operation of a disease, destroying at the same time the nervous and reproductive power, as in putrid fever, in

scorbutus, in a metastasis of gout to the brain, &c. then putrefaction commences very early, and proceeds very rapidly forward. Between these extremes are placed the other kinds of death, according as they favour or impede the process of putrefaction.

Rem. 1. We must avoid confounding with putrid fever, the common typhus, in which the brain is generally found hardened, and the body retains its soundness for a long time, 100. *Rem. 2.*

Rem. 2. To arsenic has been attributed the peculiar property of preserving the dead bodies of persons poisoned by it from putrefaction, and all that relates to this subject may be found in Fr. Ludw. Augustin's Repertorium für die öffentl. und gerichtl. Arzneiwissenschaft. Berl. 1810, 8vo, 1. St. S. 1—36., where some experiments on animals are also related in support of it. This subject, however, can scarcely be considered as decided, and it probably depends on coincident circumstances. When a person is destroyed by small doses of arsenic, the case is not at all in point; the ground where the corpse has been buried, the depth of the grave, &c. must all be taken into consideration. That arsenic, when applied after death, protects bodies from putrefaction, affords no conclusion, for the same thing is effected by corrosive sublimate, although persons who are poisoned by it very quickly pass into a state of putrefaction. All those cases in which putrefaction has commenced after poisoning from arsenic, can scarcely be denied.

204.

External circumstances have the most powerful influence on putrefaction. When exposed to the air at a low temperature, it commences very slowly, and proceeds as gradually forward, and never attains the highest degree. Spots are first discovered on the body; then a green colour; a dirty moisture appears on the surface, the cuticle separates; all the solids, with the exception of those containing earth, are soft, loose, and collapsed, and the abdomen is distended by gas. The bright green colour of the abdomen becomes gradually

darker, which it communicates to the muscles in its region (one of which, from this circumstance, formerly received the name of lividus); the parts sink more and more, are partly dissolved, and partly separated in the form of gas. The sulphuretted, phosphuretted, and carburetted hydrogen gases, ammonia, water, and carbonic acid, are particularly evolved. The brown or darkish coloured drying residue, consists of bones, cartilages, &c. in which fat, carbon, ammonia, &c. are found.

Putrefaction generally proceeds more gradually when the body is placed in the earth, particularly as it is modified by dampness. In a large quantity of water, a greater proportion of it is converted into adipocire.

At a great heat, as in summer, particularly when the atmosphere is damp, putrefaction proceeds forward very rapidly. The surface of the body quickly becomes of a grey, green, or a greenish black colour, the cuticle rises in vesicles which break, and disagreeable fluids are discharged from the natural apertures, as the nose, the mouth, &c. The tumid abdomen bursts, and a disgusting smell spreads around the apartment. Every thing is quickly decomposed, and even the hard parts begin to be destroyed, so that the air, the insects, and reptiles, soon consume the greater part of the remains.

Rem. In northern regions we generally have scarcely any conception of the rapid progress of putrefaction. In southern Europe, for example, a fish is scarcely dead when all the brightness of its colour vanishes; it appears dull, dirty, the eyes are sunk, and in the night, perhaps twelve or sixteen hours after death, we already find it in a state of phosphorescence.

This rapidity of putrefaction is certainly a very fortunate circumstance for the inhabitants of these countries, as by this the baneful remains of dead bodies are quickly dissipated, although, at the same time, it limits the efforts of the naturalist, on account of the bodies loosing so quickly their natural appearance.

With respect to phosphorescence, I have frequently remarked it in Naples, in sea-fishes, particularly in the scomber-kinds, but also in the craw-fish and crab. Fine luminous borders were generally evident on the stream, where they hung together with their bodies, and opercula branchialia. It was exactly the same light as that of the glow-worm, except that it is here ascribable to the commencement of putrefaction. This same phosphorescence has, in warmer countries, been observed in the flesh of the mammalia, and I doubt not but it may also be observed, under favourable circumstances, in the dead human body. The traditions, on the contrary, in which it is said that luminous appearances have been observed in graves, scarcely merit belief, particularly as this light is ascribed to mouldered bodies, viz. those of the saints, as they are called.

On this luminous phenomenon, vide Heinrich. Dritte Abtheilung, S. 366. Treviranus, Biologie, V. S. 127.

205.

Putrefaction does not always commence at one and the same place, but is regulated according to circumstances.

When any part of the body has been diseased during life, and thus become more susceptible of death, putrefaction commences in it, and from an external inspection we can form a pretty accurate judgment in such cases. When, for instance, the right lung has been diseased, we see that that part of the skin which covers the same side of the chest, first changes its colour ; and with the other parts in like manner.

Putrefaction otherwise, commences very late in the lungs, and then the edges and their notches are set with borders of small air-bladders ; they then stink, and become discoloured.

When death, on the contrary, is occasioned by more general circumstances, putrefaction first commences in the abdomen, which is favoured by its containing the bowels, and the gases which are disengaged in these ; the abdomen, in this case, becomes green, tumid, &c.

If any part be particularly exposed to heat, as that of the sun; or if the weight of the body rest on any particular part; or if any part of the body be laid open, so that its interior be exposed to the air, putrefaction is then more quickly or more particularly developed in such parts.

Rem. It is with regret that I feel myself obliged to mention the *Versuche über das Leben und seine Grundkräfte* of C. Aug. Weinhold. Magdeb. 1817, 8vo. Leaving out of the question the idea, that the parts of a dissected fœtus attract each other, which is ascribable to a mere delusion, I must declare it as false, that a body, from which the brain and spinal marrow are taken away, can retain its figure longer than any other. Weinhold is far from the truth in imagining, that putrefaction proceeds from the brain, and acts destructively on the body: Can we find the brain after eight, or even after fourteen days, any way changed, except somewhat in consistence, unless the scull-cap be previously detached? When the head indeed is opened, putrefaction may very easily ensue; and on the contrary, when the trunk is freed from all its contents, it will remain sound a long time. But this septic power of the brain and spinal marrow is nowhere evident from this;—the nerves dry up while the muscles putrefy, and the brain and spinal marrow, considered in relation to the soft parts, exist a long time, and may more easily be dried by spirits than many other organs.

206.

There are numerous circumstances which prevent the dead subject from passing into putrefaction, but they appear more or less to agree in this, that they extract the moisture of the animal body, or they confine its action. This last, for example, happens in the cold, by which means the dead subject retains its figure for centuries, as we have seen in animals of an earlier creation, which have lain buried under ice, until by storms and drifts of ice they are exposed from their bed, and appear, to our surprise, to be still possessed of soft parts. The former happens by exsiccation, viz. at a

strong, dry heat, as, for example, in the Arabian deserts, where human and animal bodies are quickly dried to mummies. A strong draught of wind, or a dry air, can also produce a similar effect at a lower temperature, but they do not operate so quickly, as there are many places in which bodies are very well preserved, as in the lead caves (*Bleikeller*) of Bremen. In the preservation of dead bodies, a great deal is owing to the effect of drying, particularly in the preparation of mummies, &c. Alcohol extracts the water from the parts, so that they may afterwards easily be preserved; arsenic and corrosive sublimate have a similar effect, but not quite so good.

Rem. The following work deserves to be mentioned before all others :
Lehre der Aufbewahrung und Erhaltung aller Körper, von J. C. Leuchs.
 Nürnberg. 1820, 8vo.

BOOK IV.

OF ZOONOMY.

207.

ZOONOMY embraces the consideration of life as a whole, in respect to its most general phenomena, and consists in the investigation of those circumstances from which it originates, as well as its principal modifying causes, by all of which it is acted on to the latest period of its existence.

Rem. 1. Zoonomy properly signifies the *Doctrine of the Laws of Life*, and all the circumstances mentioned in the above section relate also to its investigation; indeed much of this ought to be received as purely such. The whole of these propositions, however, cannot yet be fulfilled, and we should have chosen another expression for them, if they had not previously been treated under the term Zoonomy, the fragments of which I now deliver to the public. The term *Biology*, comprehends too much, particularly since the large work of Treviranus has appeared under this title.

Rem. 2. I would willingly have treated the subject of psychical life in this book also, but I have frequently attempted it, and found it inconvenient; I must therefore leave it for the next.

Rem. 3. The literature connected with this subject is extensive, and comprehends many excellent writings, some of which I have already had

occasion to refer to, viz. of Barthez, Darwin, Treviranus, Nysten, Prochaska, &c. and will mention others under the different chapters of this Book. The following may be here mentioned :

Cph. Ludw. Hoffman, *De sensibilitate et irritabilitate partium libellus*. Düsseld. 1794, 8vo.

J. Lud. Gautier, *Diss. de irritabilitatis notione natura et morbis*. Hal. 1793, 8vo.

K. Fr. Kiemeyer, *Ueber die Verhältnisse der organischen Körper unter einander in der Reihe der verschiedenen Organisationen, die Gesetze und Folgen dieser Verhältnisse*. Stuttg. 1793, 8vo. A new edition, Tübingen, 1814, 8vo.

J. Uhr. Gottlob Schäffer, *Ueber Sensibilität als Lebensprincip in der organischen Natur*. Frft. a. M. 1793, 8vo.

J. Dan. Metzger, *Ueber Irritabilität und Sensibilität als Lebensprincipien in der organischen Natur*. Königsb. 1794, 8vo. †

Hnr. Fr. Link, *Ueber die Lebenskräfte in naturhistorischer Rücksicht*. Rost. und Lpz. 1794, 8vo. (Also in his *Beiträge zur Naturgesch.* 2. St.)

C. F. Clossius, *Anmerkungen über die Empfindlichkeit und Reizbarkeit der Theile*. Tübing. 1795, 8vo. †

J. Fr. Blumenbach, *Pr. de vi vitali sanguini neganda, vita autem propria solidis quibusdem c. h. partibus adserenda*. Gott. 1795, 4to.

J. Chr. Reil, *Von der Lebenskraft*. In his *Archiv*. 1. B. 1. St. S. 8—162. This, in my opinion, is the best of all Reil's writings, and has been the principal means of acquiring him so much fame.

Dav. Madai, *Ueber die Wirkungsart der Reize und der thierischen Organe*. In Reil's *Archiv*. 1. B. 3 St. S. 68—148.

J. Fr. Ackerman, *Versuch einer physischen Darstellung der Lebenskräfte organischer Körper*. Frft. a. M. 1797, 1800, 2 Bde. 8vo. Zweite Ausg. Jena, 1805, 8vo.

Theod. Ge. Aug. Roose, *Grundzüge der Lehre von der Lebenskraft*. Braunschw. 1797, 8vo. Zweite Ausg. das. 1800, 8vo.

Alex. v. Humboldt, *Ueber die gereizte Muskel- und Nervenfaser*. Berl. 1797, 2 Bde. 8vo.

Dav. Veit, *Diss. de organorum c. h. tam energia quam sympathia*. Hal. 1797, 8vo.

Köllner, Prüfung der neuesten Bemühungen und Untersuchungen in der Bestimmung der organischen Kräfte. In Reil's Archiv. 2. S. 240—396.

Hoffbauer, Ueber den Begriff des Lebens und der Gesundheit und Krankheit, als Zustände desselben. In Reil's Archiv. 3. S. 465—476.

Xav. Bichat, Recherches physiologiques sur la vie et la mort. Paris, an VIII. 8vo. Second edition, 1802, 8vo.

Fischer, Ueber den Unterschied organischer und nicht organischer Körper. In the N. Schriften der Berl. Ges. Natf. Fr. B. 3. S. 348—370.

J. J. Dömling, Kritik der vorzüglichsten Vorstellungsarten über Organisation und Lebensprincip. Würzb. 1802, 8vo. †

K. Ge. Neumann, Versuch einer Erörterung des Begriffes Leben. Dresden, 1802, 8vo.

A. H. F. Gutfeldt, Ueber das Verhältniss der Wechseleerregung, Nervenwirkung und Bewegung im thierischen Organismus. Gött. 1803, 8vo.

J. Rud. Deimann, Ueber die Grundkräfte nach Kant. In Reil's Archiv. B. 6. S. 491—517. Also his paper in the same work, p. 518—548, entitled: Ist die Lebenskraft im Thier- und Pflanzenreich der allgemeinen Grundkraft der Materie untergeordnet, oder ist sie eine eigene Grundkraft. Das. S. 518—548.

K. Eb. Schelling, Ueber das Leben und seine Erscheinungen. Landshut, 1806, 8vo. †

Troxler, Ueber das Leben und sein Problem. Gött. 1807, 8vo.—His Elemente der Biosophie. Lps. 1808, 8vo. †

F. P. Cassel and A. M. Wallenberg, Skizzen für Zoonomie. 1. Thle. 1. H. Köln. 1808, 8vo.

Gottfr. Chr. Reich, Sind die Gesetze des Lebens höherer Natur als die allgemeinen physischen Gesetze der todten Materie? In Schr. der Erlang. Ges. 1. B. S. 423—456.

Le Gallois, Expériences sur le principe de la vie. Paris, 1812, 8vo.

Aug. Fr. Schweigger, Cogitata quædam de corporum naturalium afinitate, imprimis de vita vegetativa in animalibus. Regiom. 1814, 8vo.

Sigism. Wolf, Vollendete Darstellung des Lebensprocesses und seiner Zustände, als Gesundheit, Krankheit und Genesung. Karlsruhe. 1814, 8vo.

A. C. Mayer, Ueber eine neue Begriffsbestimmung des Lebens. In Meckel's Arch. 3. S. 84—104.

Günther, Ueber den Begriff des Lebens, in the same work, 553—555.

C. G. Carus, Ueber die verschiedenen Begriffsbestimmungen des Lebens. ib. 4. S. 47—60.

J. Bern. Wilbrand, Das Gesetz des polaren Verhaltens in der Natur. Giessen, 1819, 8vo.

Koreff, über die Erscheinungen des Lebens und über die Gesetze, nach denen es im menschlichen Organismus sich offenbaret. Berl. 1820, 8vo.

CHAPTER I.

OF THE PHENOMENA OF LIFE IN GENERAL.

208.

All *organic bodies* distinguish themselves from those of the inorganic kingdom, by being composed of parts or organs, which collectively and individually contribute to the support and growth of the whole, by passing through certain degrees of developement, and by exhibiting a periodicity in their action.

Rem. The expression *organism* is consequently quite definite, and it is in vain that some authors have attempted to arrange the inorganic directly on the organic bodies, for they are evidently so widely removed from each other, that to approximate them is a thing impossible. When we are unable, in the concrete form of any body, to determine to which of these classes it belongs, this can by no means be considered as an objection to the position, for we are only able to give a decision with respect to such substances as we fully and accurately understand. It would appear extremely rash and superficial in any person to decide without investigation. But according as we are able to arrange these in a suitable order, will we become the more likely to judge of them with accuracy.

We ascribe *life* or *vitality* to those bodies or organisms in which we observe the existence of action. This expression implies nothing different from organism, but only its *organic-being*, recognized by us ; in the same way as the expression *death*, distinguishes that condition of the body in which vitality has ceased to exist, and in which it no longer appears as an organism, but merely as its inorganic remains, or the corpse. It is also possible in some cases to be uncertain whether the body be actually dead or not (vide 2.) ; as perhaps the recently dead body may not be sufficiently distinguished as such, by the form and other individual symptoms ; and in this case we either refrain giving any judgment, until we are enabled by further observation to give it with certainty, or we say that the body is at present in the state of *asphyxia*.

Rem. As we would merit no blame from being unable to tell with certainty whether a human body, lying at a distance, were a person sleeping or a corpse ; neither can we deserve it, when, on account of the very fallible symptoms, we are unable to decide with certainty in the above-mentioned case. The symptoms of vitality are frequently very indistinct and obscure, as for example, in an animal ovum, or a vegetable seed ; in animals which are torpid, frozen, &c.

All organic bodies are comprehended under the animal and vegetable kingdoms, both of which, in their simplest forms, approximate very nearly to each other ; but the more they are developed, so much the more do they diverge.

Rem. 1. It would be very natural to imagine that the most perfectly organised vegetables would rank next to the lower classes of animals ; this, however, is nowhere the case ; it is only at the commencement (*rudiments*) of each chain that they resemble.

Rem. 2. Some authors have, on this account, attempted to comprehend the simplest plants and animals together, under a medium kingdom, but they have always been obliged again to give up the task, as nothing but unnatural distinctions and arrangements have resulted from it. We cannot, therefore, approve of the plan of Chr. Ludw. Nitzsch, in an otherwise excellent work (*Beitrag zur Infusorienkunde*. Halle, 1817, 8vo, S. 78—118. Taf. 3—6.), in representing animals and plants under one genus (*Bacillaria*), as animal and vegetable species.

Rem. 3. We have also an example, where the parts of an animal, and among these the hard parts, have been considered by the most enlightened naturalists as distinct animals; but this will only make us so much the more cautious in our observations, by which we may avoid a number of errors. Otto Fr. Müller (*Zool. Dan. Fasc. 1. p. 16. tab. 16.*) has mentioned a living genus of animals (*Pedicellaria*) existing on the Echini, of which he has observed three species, viz. *P. globifera*, *triphylia*, and *tridens*, Linn. Gmel. T. VI. p. 3136. Fr. Tiedemann (*Anatomie der Röhrenholothurie, des pomeranzenfarbenen Seesterns und des Steinsiegels*. Landshut, 1816, fol. S. 68.) has very properly described them as parts of the Echinus, without, however, mentioning that they have been considered by others as distinct animals. Fr. Rathke, on the contrary, (*Skrivter of Naturhistorie Selskabet. 5. B. 1. H. Kiöbenhavn, 1779, 8vo, S. 123, 138.*) very positively asserts, that the *Pedicellaria* are parts of the Echinus. Cuvier (*Regne Animal, T. 4. p. 69.*) considers them as polypi, which seek refuge on the Echini, while S. Nilsson (*Vet. Ac. Handl. 1818, p. 90—99. Tab. 3. Beskrivning öfver Slägtet Pedicellaria,*) has added a fourth species to those of Müller, viz. the *P. dentata*, but observes that these animals are firmly attached by the foot.

These, however, are decidedly no animals, but are the parts of the Echinus, exhibiting a calcareous border, moving all together; and living and dying with the Echinus; they are found on every individual of these, and are coloured according to the particular colour of the species to which they are attached: of which circumstance I have convinced myself by repeated observations at Naples.

The rigid cellular structure of vegetables (67.) is very characteristic of these bodies, when we compare it with their soft and formless elements. All their organs likewise, are so firmly connected with each other, that no one of them can move of itself, and even of the external parts, it is only those which are connected by joints that admit of motion, and which is effected merely by force or elasticity.

Rem. 1. Let us only compare the flight of the stamina in the *Lopezia*, *Berberis*, &c. or that of the seed in the *Impatiens*, *Geranium*, or even the more extensive motions of the leaves in the *Dionæa Muscipula*, *Hedysarum gyrans*, *Mimosa pudica*, *sensitiva*, &c., or those of the *Oscillatoria*, with the movements of animals of any order whatever: in the former, it is like the uniform and mechanical motion of the seconds of a watch, while in the latter, we observe the greatest diversity and multiplicity of motion.

Oken formerly imagined that the spiral vessels answered the same purpose in vegetables, as the nerves in animals; but the woody fibres of these vessels have nothing in common with the nerves of animals—in soft mucus, loosely embedded, delicate, and continually changing parts.

Rem. 2. It is very improper to ascribe loco-motion to vegetables, because in some the roots or bulbs are lost in one place, and spring up again in another, or because some climb or creep forward; for this latter is only the growth and increase of the vegetables, and the former is referrible to the short duration of certain parts, while the new parts are never found altogether to arise from the same place in which the old ones were situated. It is only in animals that loco-motion exists, and in these throughout the whole. I know only of one circumstance in the vegetable kingdom, which at first sight might be considered as such, viz. the separation of the male flower of the *Vallisneria*, in order to come in contact with the female flower; but this also is an impulse, and no voluntary movement. How altogether different from this does the separation of the vorticellæ from their stalk appear, in order to swim about as infusoria,

which I have observed in the same way as O. Fr. Müller on the Vorticella Convallaria.

212.

All the parts of every organism, however various they may be in their structure, in their composition, and in their action, are, without exception, to be considered as organic, and consequently, as living.

Rem. 1. Some of the solids have been viewed by physiologists as dead matter; as in animals, the epidermis, the nails, the hair, and likewise the bones; together with the analogous parts in vegetables, as the wood, but improperly; for all these parts develop themselves organically, and are in organic connexion with the rest. Living and dead parts can never be so reconciled, but when the living part is sufficiently powerful it forces the dead part out, and when this is not the case, it is then drawn within its sphere, and dies with it. This is observed in the sphacelus of soft parts, and in the necrosis of bones. Living parts may be planted into many organs, but this cannot be done with dead parts. When bodies which are dead, and consequently foreign to the organism, remain in it, as for instance, a blighted extra-uterine fœtus, a ball, &c., they must be surrounded by suffused coagulable lymph, or earthy concretion, and are thereby separated from the organisation. If this does not take place, they are thrown out of the body by the consequences of the inflammation which they excite, by suppuration, or gangrene.

Rem. 2. The fluids, however, have been much more frequently considered as without life, particularly since the days of Brown, who considered them merely as the external stimuli of the system. This, however, cannot be admitted, as they stand in the closest connexion and intercourse with the solids, so much so, that the most trifling function of an organ cannot be supposed to take place without their assistance. They are all likewise of a peculiar kind (147.), and are only present in systems; they are for the most part easily changed to solids, and partly also exist in their interior; and lastly, they exhibit changes in disease. All these circumstances are particularly ascribable to the blood.

It must be admitted, that the fluids only represent the first step towards life, and that they rank lower in vitality than the solids, but they can never be considered as dead matter, for then they would operate injuriously on the system, and consequently must be removed, or they will destroy.

Rem. 3. The excrement (*Excrementitia*) and concrement are dead substances, and foreign to the body; they must consequently be expelled, or they will operate injuriously on the system; but the concrements are sometimes enveloped, and in this manner they may, like other foreign bodies, be borne a long time.

Rem. 4. As all the parts of the body are vital, the seat of life cannot be sought for in any one part of the system. There are certain organs of great influence, particularly in a compound system, which are to be considered as the central organs, the suppression of whose action is therefore very injurious, and indeed fatal; on which account the study or investigation of this influence becomes very useful, as will be shewn more clearly in the Special Physiology; but in this there is nothing which could lead us to the belief that life is seated in any one particular part. From the great variety of systems, and the absence of central organs, in many animals as well as plants, this seat must have been considered as varying very much, and indeed in a great many it must have been considered as altogether wanting.

213.

The property common to all the parts of every system is incitability (*incitabilitas*), or the peculiarity or power of being excited (*incited*) by stimuli (*incitamenta*) to re-actions.

Rem. 1. The word Incitabilitas is much less ambiguous than Irritabilitas, an expression used in so many various senses, which is sometimes altogether of a general signification, and as synonymous with the above; it is used by Gaubius to signify the increased morbid irritability; by Haller, on the contrary, as by nearly all physiologists of the present day, to denote the muscular power; while the word Incitabilitas, particularly since the

time of John Brown, only implies the general incitability of the system.

J. Brunonis Elementa Medicinæ. Recus. Hildburgh, 1794, 8vo.

Rem. 2. Sensibilitas, Contractilitas, and all our expressions of this kind, are insufficient, in so far, as they rather signify, according to the formation of the word, a capability to be changed, or something passive, instead of implying, together with the capability, their active power.

214.

At the moment when organisation commences, the system is in a state of incitability, which exists in all its parts throughout, as long as organisation itself exists.

Rem. This proposition is often expressed in such a manner, as if the stimuli particularly effected excitement, i. e. leaving excitability, or the capability of being excited, out of the question; and indeed so, as if life were a state effected by the power of stimuli. But as we can effect no excitement without stimuli, neither can we be susceptible of stimuli without incitability.

215.

The stimuli are partly *internal*, consequently, originating in the system itself; partly *external*, or existing in the surrounding system of (organic or inorganic) nature.

Rem. We might say, in a certain sense, that all stimuli are external, i. e. in so far as the action of any one part of our system on another part of the same may be considered as external to that part: but as the system, and all its parts together, make a compound whole, it is much better to consider all that takes place in it as something internal.

Brown (El. Med. Cap. 11, 12.) considered the nervous and muscular action alone as internal; but every thing else, even the blood and the secreted fluids, he considered as external stimuli. He should have been

still more precise, and only have admitted the action of the sensorium on itself and the rest of the system as internal stimuli.*

216.

Stimuli are either *psychical* or *physical*; the latter are either *chemical* or *mechanical*.

Rem. 1. We denominate those stimuli psychical, which arise from the mind, or are capable of acting on it, without our being able to consider the matter itself as the operating cause. It is understood from the intimate connection of the sensorium with the rest of the body, that the one cannot be affected without the rest being affected at the same time, but then, we are always able to discover their heterogeneity. When, for example, by the description of the moral power which resides in us, we excite any one to a noble determination, or when, by contemplation, we at length arrive at a fact, we can by no means consider this as physical.

Rem. 2. Physical stimuli can only act chemically or mechanically, and it may be either in one of these ways, or, as is general, in both ways at the same time. It is frequently said, that stimuli act either chemically, mechanically, or dynamically; the word vital is also frequently used instead of the latter term. Neither of them can be commended. All stimuli may be denominated vital or dynamic, inasmuch as they only act on the living body, and inasmuch as they are ascribable to a power or cause, which we do not understand; but we can only represent to ourselves the mode of their action, as chemical or as mechanical. To reckon yet a third, or dynamic mode of action, signifies as much as that we accurately understand the mode of action of the others, which, however, is not the case. If we say with Plenck (*Physiologie der Pflanzen*. Wien, 1795, 8vo, S. 2.), that organic bodies are composed of solids, fluids, and a vital power, we might likewise conceive to ourselves stimuli, which act upon this last constituent. But as the one does not exist, the other of course falls to the ground. Whenever a stimulus deranges the action of an organ, or causes a lesion of continuity, and if at another time this is followed by a great general action, this action must be considered as consisting either in the deranged state of the organ, or of the whole system.

The various parts of the system exhibit very different kinds of re-action, and sometimes possess peculiar stimuli.

Rem. This also was frequently attributed more to the stimuli themselves, than to the variety of incitability of the organs, which, however, cannot be admitted. The stimuli have also been divided into common and proper; but this distinction, however judicious it may at first sight appear, cannot be followed throughout. A poison, for example, which quickly destroys life, may appear to act generally, but by closer investigation we find that it first acts on certain organs, or systems of organs, and by the destruction of these produces a general death. We can act by galvanism on a small part; but by a more powerful application of it, we observe its effects through the whole system. The same thing is observed in various other ways.

It cannot be denied that there are particular bodies which exhibit a peculiar (specific) stimulus on certain organs, as, for example, the cantharides on the urinary organs, narcotic poisons on the iris, but besides these, they produce a number of secondary effects, and the specific excitement arises principally from the particular incitability of the organs.

The usual excitement of some parts of the system, as for instance, that of the fluids, and the harder solids, can only be known by an accurate comparison of them in the healthy and diseased conditions.

Rem. In the highly morbid condition of hard parts, the excitement may become very evident, viz. in the bones during an inflammatory state. In the fluids we must particularly look to the colour, the smell, the altered consistence, the change of composition, and the difference of their decomposition, as for example, in the blood drawn from a vessel.

For the other (soft) parts of the system, of the vegetable, as well as of the animal world, there is one common character of the state of excitation, or of excitement to a certain degree, or turgidity (*turgor*), which may be by degrees diminished or increased, and only ceases with death.

Rem. We observe in plants a degree of weakness, or a withering appearance, when they are not sufficiently supplied with water, but as soon as they are watered sufficiently, they appear lively and vigorous. The most powerful man, after a great loss of blood, sinks from weakness; his eye becomes dull; in joy it is bright or full of vivacity, in inflammation it is painfully turgid, &c.

Ern. Benj. Gottl. Hebenstreit, *Doctrinæ physiologicæ de turgore vitali brevis expositio*. Lips. 1795, 4to. On this subject—Reil in his *Arch.* 1. B. 2. St. S. 159—178.

G. R. Treviranus, *über Lebensturgescenz*. In his *physiolog. Fragm.* 1. Th. S. 57—102.

J. Fr. S. Posewitz, *Bestimmungen des durch die Gefäss- und Nervenporen entweichenden flüchtigen stoffs*. Giessen, 1803, 8vo, S. 19—36.

Next to this common turgor (219.), many systems of organs, in more complicated organised bodies, distinguish themselves by the peculiar direction of their increased irritability, so that we distinguish it from the general incitability of the other organs by particular names. In membranous parts we call it *tension*, *contractility*; in muscles *muscular power*, *irritability* (*Irritabilitas*); and in the nerves, *nervous influence*, *sensibility* (*Sensibilitas*).

The moral influence (*vis psychica*) distinguishes itself from all the others, but approximates more to nervous power than to any other.

Rem. 1. Contractility is the only one of these conditions observed in vegetables, for their power of motion; even that of the *Hedysarum gyrans*, &c. (211.) can be attributed to nothing else; as, in the first place, they depend so much on external stimuli, and in the second place, on account of the uniform mechanical appearance of it, and also their rigid vegetable structure, they could not allow of any thing else than a mere contraction and relaxation of their parts. On no account can it be compared with muscular irritability, which distinguishes itself so prominently by the oscillations of the fibres; neither is there throughout the whole vegetable kingdom, any thing analogous to muscles to be found; if we dissect, for instance, the moving parts of the *Mimosæ*, or *Hedysarum gyrans*, *Averrhoa Carambola*, &c., we will find the same rigid, woody cellular-membrane, the same woody vessels, and only a notch for the joint, by which this kind of motion may be effected. But if it be necessary to distinguish these plants by any peculiar property, without taking into consideration, that all sleeping plants, whose flowers or leaves are sunk, rank very near to them, then let this be signified by a distinct term, only not by that of muscular irritability, with which it has nothing in common. Still less, however, can we consider plants as possessing any sort of nervous power or sensibility, and when J. Hedwig (*De fibræ vegetabilis et animalis ortu*. Lips. 1790, 4to, p. 6.) ascribes to them a sort of mind (*psychidium*), we must excuse it on account of his excessive love for the kingdom of vegetables.

Rem. 2. There is a great diversity in animals with respect to their internal structure, and their expressions of life are consequently also different. But when we contemplate the whole animal kingdom, from the tribe of mammalia down to the infusoria, we find that, in spite of all other distinctions, there is, even in the most simple of them, a much nearer approach to animals of the highest organisation, than to any vegetable whatever, which arises from their volition. So that a pervading property is evident in them throughout.

Let the organs be never so little developed, the mobility is, notwithstanding, of such a kind, that we cannot altogether consider it as mere contractility. We are thence obliged to admit, either that we are destitute of the means of acquiring an accurate knowledge of the delicate

structure of the simplest animals, or that the nervous and muscular substances exist with the rest of their parenchymatous structure, and that the whole is thereby rendered irritable and sensitive.

The higher mental power is lost in the brute creation (vide 25—35.), but the lower sensitive powers are observed to exist in them in various degrees and combinations, relative to which the most important circumstances will be brought forward in the next book.

CHAPTER II.

OF THE SOURCE OF LIFE IN GENERAL.

221.

When we attempt to investigate the origin of life, our progress is obstructed on all sides, and we are disappointed in our expectations of obtaining the wished for satisfaction. This is the general complaint. But we cannot conceal from ourselves, that we proceed just as far on this subject as on others, and that in every other, as well as in this, the key-stone is wanting. Could we come to a perfect and accurate knowledge of this or any other subject, we would then be possessed of it on every thing else throughout the whole range of nature.

Rem. Let us take a glance over the whole science of Physiology, Pathology, Chemistry, Natural Philosophy, &c. and we will find that they are all in the same condition. We are every where engaged in attempting to raise the veil of truth, but we are scarcely able to disturb it.

Were only something effected by chemists or natural philosophers, nothing could then prohibit us from observing the light also.

222.

The causes of life have been considered by many as partly chemical ; and these have been sometimes attributed to one, sometimes to more substances. Thus some authors have represented oxygen, others caloric, and a third the electric matter, as the peculiar sources of life. Others again have attempted to explain life as the effect of the reciprocal action or conflict of oxygen, carbon, nitrogen, and hydrogen. But these opinions are not only voluntary and without proof, but they are false. All those substances which have been treated of in the third book, are indispensable to life, but from them alone we never could deduce the origin of life ; for we find them in the dead remains of organisation as well as in inorganic bodies. Let warmth penetrate their structure in never so high a degree, let them be subjected to the influence of electricity, whether its effects be powerful or weak : still they will never acquire any vital property.

Rem. I consider it as quite superfluous to go through the various hypotheses on this subject more closely, and shall content myself with mentioning the chemical views of Baumes, in which he mentions a chemical physiology and pathology, and distinguishes all diseases into the oxygenous, caloric, hydrogenous, azotinous, and phosphoric. That there is some truth here and there throughout this system, does not make it the less objectionable, as the whole cannot be admitted, and it is the whole that we have to judge of. We are amazed at the views of the older chemists, in any thing that concerns physiology, pathology, and therapeutics, which later ones by no means surpass, as by both of them the subject of life is thrown in the back-ground. They speak, indeed, of a *Chimie vivante*, but this is nothing more than a name ; the great evil remains, viz. that from the gratuitously accepted, or false premises, a

number of positions are accurately deduced, or appear to be so, and thus the most unsatisfactory, the most improbable circumstances, are blended together, and pass for truth.

223.

Much more reasonable is the manner which was instituted by Reil. He does not mention matter, nor deduce life from matter, purely as such. He considers life as the effect of the form and constitution of matter, and indeed we can attribute it to nothing else when it is agitated concerning life in general; and it is with great impropriety that Hildebrandt left the form out of the question, and attributed it solely to the constitution. The constitution can only be capable of assuming the vital state, and the life, or vitality of the system, commences primitively with the form.

What constitution it is which qualifies the form of the future system, is altogether hidden from us; but this much we know with certainty, that such an one is only capable of life, which has received its origin from other organised bodies. It is quite determined with respect to most organic or living bodies, that they derive their being only from organisms of the same kind; we have also reason to suppose that other more simple organic bodies likewise originate in the same way; but an organic body is never derived from an inorganic source.

We are consequently obliged to maintain, that *life arises only from the form and constitution of organic matter*; but the explanation is very much confined by the circumstance, that this quality must in the first place be presupposed.

Rem. 1. I refer for further information on this subject to Reil's paper mentioned 207., and to Hildebrandt's observations in his *Physiologie*, S. 46. &c. When a peculiar organic matter is denied by so many, this is merely because we are acquainted with no peculiar organic funda-

mental principle, or because we have no sufficient data to enable us to take one for granted. On the contrary, we find peculiar combinations of the same, which we are not capable of producing by art, but which are only found in organised systems ; by these, variously modified, the germ of vitality is effected, and life propagated in all its various forms : vide 133, 147.

Rem. 2. A late author, J. B. Fray (*Nouvelles expériences sur l'origine des substances organisées et inorganisées*. Berlin, 1807, 8vo.), has indeed asserted, that he has seen infusoria arise in pure water, when all organic substances were taken from it ; but this will be credited by no one who has instituted experiments in this field. He indeed refers to the verbal evidence of Berthollet, but this author judged quite differently on the subject, as might be expected. We will treat further on this subject in the doctrine of generation.

224.

Other physiologists rather deviate from the constitution, and in its stead adopt a peculiar *vital power* (*vis vitalis*), which calls forth life in the system. And this opinion is certainly to be approved of, when it is wished briefly to mention the unknown cause of life ; but it is extremely objectionable to presume that they have thereby explained any thing, or as if, by this representation, the vital power were a something which was given to the system, and produced animation.

Rem. 1. Authors generally commence at first with the modest declaration, that they mean, by the word vital power, no more than the unknown origin of life ; but this mask of modesty is presently thrown aside, and they proceed as if the thing had been quite clearly proved. It is now become a *something*, which is imparted to the body in a certain quantum ; and they talk of increased and diminished, exalted and fallen vital power, &c., and thus they have a *Deus ex machina*, which must help them through all obstacles. In such a case was Brown with his *incitabilitas*.

Rem. 2. The vital power of later authors is the *Ενορμὴν* of Hippocrates, on which the work of Abr. Kaau Boerhaave, *Impetum faciens Hippocrati per corpus consentiens*, 1745, 8vo, is well worth the reading. The *Archæus* of Paracelsus, which is generally considered as the same thing, properly signifies a generally extended power of nature. Paracelsus distinguishes therefore an *Archæus Microcosmi*, which suits us better, and also speaks of an *Archæitas*, viz. *Stomachi*. Helmont, on the contrary (in the *Ortus Medicinæ*, l. v.), frequently speaks of the *Archæus* exactly as the vital power is now spoken of.

225.

Instead of one, to admit of *many vital powers*, does not at all improve the matter; and only makes it so much the more obscure and confused, when they are viewed as independent, and arranged each for itself. For, if a unity must arise therefrom, which, in the system is undeniable, what is the cause of it? Is it perhaps the general vital power arranged above these again? This again should give place to the universal All, dwelling also in the most simple bodies. Here we are fallen into a labyrinth, which is certainly not necessary.

We are not, however, to be blamed, when, for the sake of brevity, we distinguish the peculiarities or actions of systems by peculiar names, in so far as they are evident to us, as is already observed, 220. The views of physiologists, however, are so various on this subject, that it is impossible to enumerate all the powers mentioned by them.

Besides the mental power, which, as has been already said, is independent of all others, it appears to me as admissible to distinguish muscular irritability and nervous sensibility from the general incitability, as indications of the same life. The reproductive power (*visus formativus*, *vis plastica*, *reproductiva*) is, doubtless, nothing more than an indication of the

general incitability, and not confined to one particular system; in so far, however, as it is neither the same in all classes or even species of creatures, nor in all the parts of the same, the opinion may be justified, as well as the corresponding *vis mediatricis naturæ*.

On the contrary, it appears to me as superfluous to adopt, with Kielmeyer, a peculiar power of secretion, and a progressive power in the blood. The former is too intimately connected with the reproductive power, as all nutrition consists partly in secretion, and partly in ingesta; the greatest variety of parts also secrete, in order to support their equilibrium and integrity; while, on the other hand, the most heterogeneous substances are secreted to effect individual objects; so that unity is only observable in these when considered in respect to the nutritive and reproductive process generally. I can find just as little grounds for adopting a peculiar moving power in the blood; it moves merely in its vessels, external to which it stands still; in higher animals it is moved by the power of the heart, in the lower ones by that of the vessels; on which we will treat more minutely in the Special Physiology; vide 111. *Rem. 2.*, 157. *Rem 2.*, 161.

Barthez adopts a power by which the parts of the body are retained in their situations (*force de situation fixe*); Dumas that of a vital resistance, with a little alteration from the former (*force de résistance vitale*), without, however, having at all enriched the science thereby. In the general incitability and turgor of all parts, organically united together by the structure, in the marked contractility of the membranes, and the still more developed muscular power, there is certainly no difficulty to explain how the most solid parts, even during the most tonic spasm, can retain themselves in their situation, as all uninterruptedly acted with, and on one another. But if we leave the above-mentioned vital powers out of the question (although improperly), then the physical powers present

themselves (Haller's *vis mortua*), by means of which all solid parts retain their connexions after death, until putrefaction has exercised her right. The fluids, which are and must be in perpetual motion, do not entirely require these powers.

The cooling power, very superfluously accepted by the English, is already mentioned, 191. *Rem.* 1.

To admit of a power proper (*vis propria*) to every part of the body, which has any thing peculiar in its function, can only be prejudicial, as we are consequently obliged to stop here, and thus the investigation is put to an end. It is certain, that an organ of a peculiar structure, must act in a way peculiar to itself; but it does not follow that there must be a proper power for such function, but the universal power of the system must produce different results in each particular organ.

Rem. The contractility of plants has already (220.) been the subject of consideration. I only remark at present, that on account of the simplicity of their construction, the action of their contractility, as *vis reproductiva*, is likewise simple; so that in them there is much more danger, in many circumstances in overlooking the influence of life, as for example, the motion of the sap. If the experiments of Matt. Gozzi (*Giornale di Brugnatelli*, Dec. 2. T. 1. Pavia, 1818, 4to, p. 199—201.) are true, the internodia of the *Chara* must have a double connexion, and the known ascent and descent in each part must be quite independent. This naturally brings the *Hirudo vulgaris* to our mind, which we can cut through the middle, and yet the circulation will go on in each half independent of the other. If the *Chara* possessed transverse vessels (which I have never seen), as they are visible in the other, then the fact would certainly not be so obscure.

226.

Other physiologists, particularly those of later years, have brought forward the hypothesis, that the powers of organic bodies cannot be distinguished from the physical powers, as they are denominated; but that they are exactly the same, only

in an increased state ;—that there is nothing dead, but a universal life throughout all nature, of which each particular life is a branch.

This idea has, at first sight, something very enticing, and we are easily prevailed on to give up the Microcosmus to the Macrocosmus. But by closer enquiry, however, we soon find that our feet are not so firmly rooted, and that the bands are not so fast which confine us. We can nowhere, nor in any manner, point out this increase ; for what similarity has elasticity to the oscillatory muscular power, or what physical power can be compared with the nervous influence ? where, in short, is the chain which should lead from the material world to that of spirits ?

Should the general life, on which all things depend, be possessed of an understanding, we would then be obliged to return again to the old doctrine of emanation, where every thing is considered as a stream of the Godhead. If such were to form the first link of the chain, then it might be possible ; but the hypothesis admits of no explanation, and prohibits every attempt at it, and is, at least in a physiological sense, altogether inadmissible.

Rem. The mystics and conjurors, who very much resemble each other, could make use of such an hypothesis to advantage. If all the things in the world depend on each other, then is a sympathetic medium and each vision authorized ; the somnambulist tastes the pepper which the magnetizer takes into his mouth, intoxicates himself with the wine which he drinks, he feels the waters rumbling under the earth, &c. for there is no separation between them.

The presence, or the entering of a spirit or soul into a body, does not in the least explain the theory of life. If we admit, with many physiologists, particularly Stahl and his

followers, that the body is formed, and the organisation governed, by the soul, we then evidently impose on it a duty for which it is not formed. How could it select and arrange matter unknown to it, and produce motions of which it comprehends nothing, and in an organisation with which itself originated?

When we divide an animal or a plant, and observe that each part retains its life, and continues its growth, what then becomes of the soul? It must then be divided likewise, in order to grow in all its parts. Aristotle indeed admitted a vegetative soul, but in order to explain this we must compare it with the soul properly so called, and we will presently perceive, that it is nothing more nor less than the vital power, or *vis reproductiva*, under another name.

228.

If we sum up all that has been said in this chapter, we will find, that we must satisfy ourselves with considering life and the system as given both at the same time, originating in and propagated by other systems, without separating the one from the other, or attributing to it a peculiar origin.

Should any one, however, employ, according to his favourite views, the chemical or the electric processes, and by these strive to discover a solution of this in the affinities and polarities of parts; or should another rather follow the theory of structure, and by means of the knife and microscope attempt to solve the enigma; or should a third choose the appearances of incitability in the healthy and morbid state, as the subject of his enquiries;—each of these will serve to enrich the science, but the one will require the assistance of the other, by which union they will contribute far more to the pursuit. Although we may not be able to arrive at the chief

object, still we know not how far a laudable zeal may lead us; we ought not therefore to desist from the pursuit.

CHAPTER III.

OF THE VARIOUS CONDITIONS OF LIFE, AND THEIR CAUSES.

229.

The most perfect harmony in the greatest developement of what is mental and physical, represents the ideal of a human organism as it perhaps never actually existed. A great developement in both respects is at most a rare occurrence; for the most part, either the mind or the body is in particular developed; they are frequently both confined.

Rem. Mankind have therefore been divided into four classes: viz. those of great mind and body; great mind and weak body; great body and weak mind; weak mind and weak body.

230.

That state of the system, where the functions are performed with harmony (*euphoria*), is denominated *health* (*sanitas*), or when they prosper with ease or power. Here there is no part obstructing the other by too much or too little energy, and all the productive processes follow their natural course.

Rem. 1. This is what is properly called perfect health, the enjoyment of which imparts a happy serenity. We extend, however, the idea, and call every one healthy who feels no uncomfortable sensation, although they do not possess this regular degree of comfort. The form of many parts, particularly those that are external, may be faulty, without their

functions (at least to appearance) suffering by it. A mal-formation (*deformitas*) may exist also while the person enjoys health.

Rem. 2. Sanctorius Sanctorius (De statica medicina. Venet. 1614, 12mo, Sect. 1. Aph. 30.) very properly brings forward the feeling of lightness and freedom as a symptom of health: "Si hæc duo simul conspiraverint, alterum quod homo se ipso leviolem sentiat, alterum quod revera non sit levior, indicabunt statum saluberrimum." This ease is understood from the freedom of the functions of the organs, or when no one of them disturbs the actions of the others.

Rem. 3. The word *strength* generally implies the muscular power (*robur*), but is also used to signify the state of health (*vigor*), or the power of life (*energia*). If these expressions were always used in the sense in which they are here applied, there would arise no misunderstanding. Brown's Sthenia, or power of incitability (which by others is denominated Hypersthenia), but particularly his Asthenia directa (weakness of incitability for want of stimuli), and Asthenia indirecta (weakness of incitability by too much stimuli), are applied in so many various senses by authors, that we cannot at best make use of these expressions; let us, for example, only compare the heterogeneous explanation of Hildebrandt in his Physiologie, S. 151.

Theod. Ge. Aug. Roose, Ueber die Gesundheit des Menschen. Gött. 1793, 12mo.

Susemihl, Von der Analogie der Krankheit mit der Gesundheit. A very ingenious fragment in Meckel's Arch. 2. S. 615—623.

C. C. F. Jäger, Ueber die Natur und Behandlung der krankhaften Schwäche des menschlichen Organismus. Stuttg. 1807, 8vo.

Hildebrandt, Ueber Stärke und Schwäche in den Organismen. Abhandl. d. Erlang. Soc. 2. S. 38—53.

231.

There are many degrees from health down to the state of disease (*Morbus*); through a disagreeable feeling of heaviness or weakness, through disgust, or an uncomfortable feeling (*Dysphoria*).

Rem. 1. We must not confound the sensation of heaviness (*Onus*, *Onerositas*) with the weight of the body (*Pondus*), of which we have

been already warned by Sanetorius. Both a whale and an insect may feel themselves light and heavy; and particularly the latter, whenever the influence of the nerves on the muscles or vessels of the periphery is disturbed, in a higher degree of which *dedolatio* arises.

Rem. 2. By disease we understand that state of the system in which its functions are disturbed. And as the object of the same, organic action, is not attained, or at least imperfectly so, we distinguish the disease as preternatural (*præter naturam*) in contradistinction to health, or their natural state. In this sense also the expression is very appropriate, for it belongs to the nature of the system to become diseased under the required conditions; as, on the other hand, it is founded in its nature, that a number of morbid stimuli are able to produce such a condition in it, as to effect its own cure. This is what is denominated the curative power of nature, *vis medicatrix naturæ*.

232.

We observe a great difference in men both in the healthy and diseased state, which happens according to *temperament*, *sex*, and *age*, and also according to *climate*, their *degree of developement*, *mode of living*, *food*, &c., and according to certain *customs* and *peculiarities* which they possess.

Rem. The more complicated the system, so much the greater is the number and complexity of these modifying circumstances, and this is in the greatest degree in man. In the simpler animals, the number of these is always the more limited, but still there are none which are entirely independent of their influences.

233.

The *temperament* (*temperamentum*, *temperatura*, *temperies*, *complexio*, *crasis*) signifies the peculiarity, or individuality of each person, in respect to his entire system, or his peculiar being, which is chiefly founded on innate circumstances, but which is more exactly determined by the connexion of the circumstances mentioned in the preceding sec-

tion. Every person has something peculiar to himself; but as there are many persons who, laying these finer distinctions (*Nuances*) aside, pretty nearly resemble each other in their principal constitutional features, we have, on account of this agreement, ascribed to all such persons the same temperament.

Rem. Authors have very frequently failed in determining the temperament, on account of having sought for its source in one part of the system only. Thus the constitution of the fluids (of the blood) was viewed, as it was considered by the school, as if the blood contained at one time more water, at another more red particles, and at another more yellow or black gall; thus they treated of the temperaments, as Haller occasionally did when on the doctrine of the blood; thus also arose the denomination of the whole as temperamentum, from its composition; and individually a temperamentum sanguineum, cholericum, melancholicum, and phlegmaticum; from which they again constructed medium states, viz. a temperamentum cholericum-sanguineum, sanguineo-cholericum. They afterwards retained these names, but treated the temperaments as justly originating from many causes, among which the relation of the psychical to the physical, and that of sensibility and irritability, rank first.

Kant very excellently treated the temperaments in respect to the feeling for the sublime and beautiful, in his work entitled: *Beobachtungen über das Gefühl des Schönen und Erhabenen*. Riga, 1771, 8vo.

J. Fr. Theod. Mallinkrott, de temperamento, quod medicorum est. Marb. 1789, 8vo. †

Guil. Ant. Ficker, de temperamentis hominum. Gott. 1791, 4to. †

Jgnaz Niederhuber, Ueber die menschlichen Temperamente. Wien, 1798, 8vo. †

J. N. Hallé *Mém. sur les obss. fondamentales d'après lesquelles peut être établie la distinction des tempéramens*. In the *Mém de la soc. méd. d'émulation*, T. 3. p. 342—394. (The grounds of this Memoir appeared in Paris early in 1807, as a Diss. by Husson, *Essai sur une nouvelle doctrine des tempéramens*.)

H. Willh. Dierksen, *Die Lehre von den Temperamenten neu dargestellt*. Nürnberg. 1804, 8vo. †

Roussille-Chamseru, *De temperamentis, dantur tria vel quatuor temperamenta?* In the *Mém. de la soc. méd. d'émulation*, T. 7. p. 339—353.

Henr. Guil. Spengler, *Diss. de temperamentis*. Berol. 1820, 8vo.

Gaet. Gandolfi, *Su i temperamenti degli animali domestici*. In *Opusc. scientif. di Bologna*, T. 2. p. 328—343.

234.

The four temperaments of the old schools, viz. T. sanguineum, cholericum, melancholicum, et phlegmaticum, were formerly received without exception, and still continue to be very prevalent. Metzger (*Anthropologie*, S. 91.) mentions only two, viz. the sensitive and the phlegmatic, but he has found no approvers. Wrisberg, in his excellent remarks on Haller's epitome of physiology, has mentioned eight temperaments: the *sanguineous*; the *sanguineo-choleric*; the *choleric*; the *hypochondriac*; the *melancholic*; the *bæotic*; the *meek* and *mild*; the *phlegmatic* or *dull*.

I would also admit of eight temperaments, which are as follows:

1. The *vigorous* or *perfect temperament*, exhibiting a favourable developement of the physical and moral, with a knowledge of their own strength, and a great independence on external circumstances.

2. The *rude*, *athletic* or *bæotic*: little elasticity, with a strong, firm body, and little mental endowment.

3. The *lively* or *gay*: great elasticity of body and susceptibility, with favourable physical and mental endowments.

4. The *restless*: a very active and favourably developed body, with limited mental endowments.

5. The *gentle, mild*: great placidity of mind, which is otherwise favourably developed, with a moderate or weak developement of body.

6. The *dull* or *phlegmatic*: a great degree of dullness and laxity both on the physical and moral side.

7. The *timorous* (delicate, hypochondriac): great susceptibility of mind predominating over a sparely developed body.

8. The *gloomy, sad* (melancholic): great susceptibility of mind, which rules over and frequently deranges the body.

Rem. By all of these temperaments, there always remains a great degree of uncertainty for each particular case, on account of so much being individual, and as the temperaments do not continue the same in the same persons ; but more particularly, as we seldom know others, and often scarcely ourselves, sufficiently to enable us to ascertain the temperament in those cases where the dispositions are not very distinct. This study ought not, however, to be neglected, either by the physician, or any other person who has any thing to do with the knowledge of mankind.

235.

The sex exerts a very great influence on the system.

The body of the man is larger, more firmly constructed in all the parts, and the outlines more acute; the bones, ligaments, muscles, and nerves, are stronger; the brain is larger; his organs of voice, respiration, circulation, and digestion, are of more extent and power. Man is less irritable, and less susceptible of feeling, consequently also, morally stronger, and better adapted for exertions; more obedient to reason than feeling; self-instructive; capable of entertaining the noblest friendship towards man; frequently despotic and unjust towards woman, yet often-outwitted and governed by

her; towards children he is quieter, more uniform in his temper, and consequently better adapted for educating them; in passions he is vehemently boisterous, often harsh and rude, but generally returns sooner to the dictates of reason; more open, more faithful, and more magnanimous.

Woman is more delicately and loosely constructed in all her parts; the organs of her voice are smaller, but more flexible; she is more irritable and sensitive, but on this account she is weaker, more—changeable, fickle-minded, whimsical, obstinate, vain, timorous, superstitious, sly, and cruel; almost incapable of friendship towards her own sex; often enthusiastic towards man; knitted to her children by love, and prepared to make the greatest sacrifices for their sake. When properly educated, she frequently excels man in behaviour, mildness, meekness, patience, and piety, and exhibits an exaltedness of soul which leaves all corporeal beauty in the gloom. When badly educated, she becomes a fury or a hyæna, and exceeds man in all kinds of wickedness.

As woman is ordained to receive the offspring, and perfect it in her system, and also to remain for some time after its birth with the nutriment provided by her system in the state best adapted for the infant, a great part of it must necessarily be constituted for this office, and these peculiar organs govern the rest of the body, or at least every where sympathize.

Women, whose generative system is not properly developed, resemble man very much in their structure, without, however, attaining their degree of strength; in the same way as eunuchs, and men who are deformed in the organs of generation, have very much of the female form, without possessing their gracefulness.

Rem. 1. The physician ought to be very careful lest he allow himself to be deceived in his observations on woman. If she can get the

least hint of what he wishes to know, if she can only suspect it (and she guesses very shrewdly), then his object is altogether frustrated. Wigand of Hamburg was long deceived by a young girl, who was almost a child, as she guessed the object of the metal which was laid before him, and played with him quite harmlessly, until Pfaff discovered the deception. I know a case, where a young girl, while tried with the swinging of a pendulum, gained from the eyes of the physician a knowledge of his intention, and allowed the pendulum to swing according to his mind. I have been present when deceptions have been practised on magnetism, spasms, and St. Vitus's dance, and have witnessed the delusion carried to the greatest extent. Even under disease, women will be noticed, and thought interesting, and this is sufficient to afford suspicion of any thing which is possible. From this also, it may be conceived, how some very sensible men have, with the greatest faith, related the most wonderful stories of magnetized females, for they never suspect how much their credulity is abused. *Mulieri et ne mortuæ quidem credendum est*, said Stoll, in his *ratio medendi*, and in every thing denominated nervousness, magnetism, &c., he is perfectly correct.

Rem. 2. When the larger brain of the female is spoken of, this can never be correct in relation to that of man, which is evidently larger, and even scarcely in relation to her finer nerves. These, as a rule, are in every respect less strong, in proportion to the age of the subject, but I have also found them as strong in the female body as in man, viz. in the extremities; here, however, there is a great deal to be attributed to the manner of life.

Rem. 3. The hypothesis of Autenrieth, viz. that oxygen predominates in the male, and hydrogen in the female, cannot, certainly, be approved of. That the bones of man are larger, and on this account contain more phosphate of lime, is nothing to the purpose, as this remains in his system; and if a greater degree of oxidation actually did take place under the stronger respiration of man, so likewise would the oxygen be more profusely expended by the greater exercise of his muscular system, &c. If any one of these be shewn to exist by any means whatever, then it must likewise be proved that these substances exist in other proportions in the blood, brain, &c. in both sexes. In like

manner also, I am unable to discern any proportionably greater degree of venosity in the female sex.

J. F. Ackermann, Ueber die körperl. Verschiedenheit des Mannes vom Weibe ausser den Geschlechtstheilen. Kobl. 1788, 8vo.

J. H. F. Autenrieth, Bermerkungen über die Verschiedenheiten beider Geschlechter und ihrer Zeugungsorgane. In Reil's Arch. 7. p. 1—139.

Moreau de la Sarthe, Histoire naturelle de la femme. Paris, 1808, Voll. 3. 8vo.

Leop. Leo, Obs. de sexuum præter genitalia differentia. Regiom. 1815, 8vo.

C. Metzger, Pr. Momenta quædam ad animalium differentiam sexualem præter genitalia. Regiom. 1797, 8vo.

236.

The *age* of mankind exerts a very powerful influence on the system, but in some periods of life it co-operates so much with the sexual peculiarities, that we are not able to distinguish the one from the other. The period of human existence is generally thus divided: infancy, childhood, youth, manhood, and old age, or senility.

The period of *infancy* distinguishes itself by the delicacy and softness of the structure, by the great degree of susceptibility and irritability, with a very active reproductive power. Subject from birth to so many irritating causes from the external world, it would inevitably sink under their influence, if it were not provided against them by long-continued sleep. At about the fourth month it first commences to smile, as the symptom of comfort, its senses begin to develop themselves, its eyes follow after the mother, it commences to grasp at the surrounding objects, &c. From the sixth month, or somewhat later, until the end of the second year, the milk-teeth appear from time to time, and this is particularly pointed out as the first period of infancy, on account of it bringing with it

so much danger, which is so much the greater the younger the child is.

The following years of infancy, formerly reckoned as long as the tenth, but now generally to the seventh year, are invariably those of the most active reproduction, and are therefore threatened with various peculiar diseases, as Scrofula, Rachitis, Hydrocephalus. The children at this age certainly appear to be aware of the distinctions of their sex, but this is by our example and instruction; if treated alike, the only difference would be a greater degree of strength in those of the male sex. They are all without malice, lively, playful, thoughtless, wearied alike, and require a long sleep. During this period (the sooner the better), the most important part of their education must be finished,—the child must be obedient and faithful.

The period of *childhood* continues till that of puberty, which arrives much earlier in the female, whose development is much more rapid; so that the young virgin, according to her manner of life, strength, &c., in the middle countries of Europe, begins to menstruate between the 12th and 16th years; in northern countries it is much later; from the 8th to the 12th years, she is, like the boy, thoughtless and gay, but then the sexes commence to separate. The boy changes his voice from the 15th to the 16th year. This is the period of rude action and self-will, and it requires much vigilance lest the awakening sexual impulse have any injurious consequences.

The period of *youth*. The girl, once thoughtless and wild, now assumes the character of the woman, is decorous and well behaved; the ungovernable boy becomes the youth, vigorous, sprightly, agreeable, and gay; the joys of life bloom to his view, and the world is opened to his ardent eye. Happy he, if he can retain to himself that purity of heart and manners which is the joy of life, for if they should be

corrupted, his strength is broken, and his mind the theatre of discontent and misery.

Both sexes are, during this period, threatened with danger on the part of the chest; and where there is any hereditary predisposition, diseases of the lungs follow as their consequences.

The male enjoys his youth for a longer period: he has to prepare himself for more severe conflicts during life. The female remains in this state generally a much shorter time; she enters early into the sphere of wife and mother, without undergoing in it any particular change, until she becomes the matron.

The age of *manhood* commences from the twenty-fifth to the thirtieth year, and continues till the fiftieth or sixtieth, so that this has been distinguished into the ages of young and of mature manhood. The less the time of youth has been abused, and the more laborious the life, so much the more uniform is the health. Otherwise, this age is particularly liable to take on disorders of the abdomen.

To the healthful and unafflicted, this age passes unconsciously into the following. In the woman, menstruation ceases from the forty-fifth to the fiftieth year, and at this time there is considerable danger; but should this pass over successfully, then there is a prospect open to a healthful old age.

In *old age* all the senses become blunted, and all the powers are enfeebled; the functions of nutrition in particular are much impaired. The muscles become thinner, and gradually disappear, and the same thing happens to the other solid parts; the soft parts harden, the arteries, and many cartilages, ossify, and all the ligaments which support the system become more lax. The spirits sink, trifling cares govern the enfeebled mind, and the aged man frequently closes the

scene of life as childishly as it first began, and is even assailed by the recurrence of infantile diseases.

Every man has his own particular friends and talents; happy is he who is conscious of them, and can seize upon their advantages as they present; who looks not with sorrow on the past, but undaunted, hails the future. This is the proper philosophy of life, which is simple, when the senses are not enfeebled by disease.

Rem. 1. The ages were sometimes distinguished by particular years, anni climacterici, viz. 7, 14, 21, &c. particularly 49 and 63, which were considered as very important, and as exerting the greatest influence on the health; this, however, is improper; but authors have long been in the habit of trifling with numbers. Experience has not in the least proved the truth of it.

Rem. 2. The consideration of the changes which depend on the age, is particularly important to the physician, because, by so many periods are produced so many peculiarities in diseases.

A. Joseph Testa, Bemerkungen über die periodischen Veränderungen und Erscheinungen im kranken und gesunden Zustande des menschl. Körpers. A. d. lat. Lpz. 1790, 8vo.

P. F. Hopfengärtner, Einige Bemerkungen über die menschlichen Entwicklungen und die mit denselben in Verbindung stehenden Krankheiten. Stutg. 1792, 8vo.

Adph. Henke, Ueber die Entwicklungen und Entwicklungskrankheiten des menschl. Organismus. Nürnberg. 1814, 8vo.

Const. Anast. Philites, De decremento altera hominum ætatis periodo seu de Marasmo senili in specie. Hal. 1808, 8vo.

Phil. Dan. Benj. Seifert, Diss. de annis climactericis. Jen. 1792, 4to.

As long as mankind are considered as descended from one original pair, we are obliged to rate the influence of climate on the system much too high, as that alone must explain every thing. We are not, however, prepared for this, as I

imagine I have sufficiently proved in the first book ; vide 33. 43. 49. *Rem.* 2. 54.

By climate is properly understood that which belongs to a particular region, in respect to its position in a certain elevation, its longitude and latitude ; the country which surrounds it, of mountains, forests, the sea, or rivers ; its temperature, humidity, the regularity or irregularity of winds, &c.

The influence of climate must be considered in a two-fold sense : 1st, The versatility of the same ; 2dly, The comparison of the inhabitants of the various climates.

The stronger and more rapid the changes of the climate are, so much the more striking is its influence. Thus the English have found it to be the most wholesome, not to bring their troops immediately from England to the West Indies, but first to Gibraltar, in order to accustom them gradually to the hot climates. This is not at all contradicted by the assertion, that people newly arrived do not equally feel the injurious effects of the same, for this is owing to their strength being unenfeebled, but after some time they exhibit themselves under the necessary conditions so much the more strikingly.

West (on St. Croix, p. 16.) considers that females endure less from the changes of climate than men ; but the cause of it is evidently this, they live more regularly, more providently, and, on the whole, more uniformly, as they are not so much exposed to bad weather, excessive labour, &c. Thus it was remarked by Carsten Niebuhr (*Beschreibung von Arabien*. Kopenh. 1772, 4to, S. IX.), whom death deprived of all the companions of his travels, that their diseases arose from their European mode of living, viz. from eating much animal food, exposing themselves to the cold evening air, &c. Paul Erdm. Isert (*Reise nach Guinea*. Kopenh. 1788, 8vo, S. 258.), in like manner attributes the mortality of Europeans to their licentious living, which is badly adapted to the nature of the

climate. To these may be added domestic troubles, disappointed expectations, diseases badly treated, and a number of other injurious circumstances, which cannot be attributed to the influence of climate.

When we view health in the abstract, we find, that the regularity of temperature in warm climates is very beneficial in diseases of the lungs, so that nothing more salutary can be recommended to them than a journey thither. Thus Humboldt (Reise, 2. S. 191.) remarks, that the tooth-ache is very seldom seen in uniformly warm temperatures, but that it already appears on the back of the Cordilleras. The lues venerea is not in warm regions the terrible disorder which prevails among us. We find that the inhabitants of these, on the contrary, are much infested with diseases of the liver, intestinal canal, and of the digestive organs in general; and also fevers of the most fatal description, which are generated in these organs, are very common, and it is particularly by these that strangers are swept away. We must here content ourselves with the examples already given.

The inhabitants of warm climates, when in cold regions, suffer from an opposite class of affections. They tremble from cold, when the temperature appears warm to us; but as gain is not their object, they are not so tormented with the furies of avarice as the Europeans are with them. It is particularly the scrofulous affection, in all its degrees, which awaits them, viz. of the lungs.

If we apply ourselves to the consideration of the *influences of climate on the native inhabitants*, we then find that these are almost inapplicable to them alone.

He that contents himself with pointing out superficially a few distinctions between the inhabitants of the frigid, temperate, and torrid zones, is employed in an easy task; but he, who strives to penetrate deeper, will be very difficult to satisfy.

That affections, in general, are less severe in northern than in southern countries, will be readily admitted. Two sons of the same parents, one of whom is born in England and the other in Bengal, exhibit very marked distinctions; the one has perhaps a deadly coldness, while the other is vehement and passionate; but then, it ought to be taken into consideration, the different people among whom they live.

What can be milder than the manners of the Hindoos? but their mode of living, their diet, and their surrounding circumstances, have a thousand times more influence on their character than the climate, for how different are the adjoining Malays, compared with them? And even they themselves are not so tame in war as the English had anticipated.

It has been asserted that aberrations of the intellect are less frequent in warm countries; but this is the case in all despotic states; for instance, in China, even imagination dares not exceed a certain limit.

How unlike each other are the Russians, Danes, Swedes, Poles, Germans, and French; and yet how alike their acts are by means of a similar education. In the same way, we find that the Quakers, Heralds, and Jews, in every country bear a striking resemblance to those of their own sect. The Dutch and German boors likewise retain their external manners, and do not alter.

We are consequently obliged to estimate the influence of climate on the whole system much lower, and besides this, to take into account their original race, their developement, manner of living, their manners, diet, clothing, &c., lest we judge partially, and consequently erroneously.

Rem. 1. Sam. Stanhope Smith (on the dissimilarity of the colour and form of the human race, &c.) mentions a young Indian, who, already much adapted to a wild life, was brought into the college at New Jersey to be educated. His wild and gloomy aspect gradually disappeared. His countenance became more affable in appearance, and the effects

of more noble feelings and conceptions had neutralized, at his fifteenth year, more than half the difference between him and the Americans of English extraction.—We daily observe the same thing among ourselves, when rude children, if they have not proceeded too far, have, by proper cultivation, become quite different persons.

To speak more individually of the other points, would be here partly superfluous, as much of this, viz. the influence of diet, motion, affections of various kinds, the difference in the access of puberty in various climates, &c., will be discussed more particularly in the *Special Physiology*; and it would partly interfere with *Pathology*, to whose province some of these circumstances more particularly belong.

The greatest part of what belongs to this subject is treated of in Zimmermann's excellent work *Von der Erfahrung*, with as great a degree of talent as of learning. The very celebrated work of Cabanis, on the contrary, is somewhat superficial: *Rapports du physique et du moral de l'homme*. Ed. 2. Paris, 1805, Voll. 2. 8vo.

Rem. 2. I shall only relate further, the *cosmical influences*, as they are denominated. It is known of animals, that many of them have a presentiment of bad weather, as they are evidently more exposed to its influences than we are, who are only sensible of something like this during the diseased condition. Thus people affected with gout and rheumatism, frequently experience similar presentiments, and when the stump of an amputated limb, &c., suffers in this manner, it is referrible to the same cause. Febrile diseases, likewise, particularly in tropical countries, where the weather is more regular, are very much exposed to the influence of the moon.

Rich. Mead, *Mechanica expositio venenorum*. Accedit *Tractatus de imperio Solis ac Lunæ*. Francof. M. 1763, 8vo.

Franc. Balfour, *A collection of treatises on the effects of sol-lunar influence in fevers and other diseases*. Calcutta, 1805, 8vo.—The principal work on this subject.

J. Kämpf (*Abhandlung von einer neuen Methode, die hartnäckigsten Krankheiten, die ihren Sitz im Unterleibe haben, zu heilen*. Lpz. 1786, 8vo, S. 563—568.), communicates some very interesting information respecting a physician named Burkhard, who attributed a great deal to these influences.

Some very excellent remarks on this subject may be found in the *Diet. de Méd.* under the title of *Lune de Virey*.

238.

The habit which arises from this, that the incitability to the above-mentioned stimuli does not long re-act to the same extent, governs the system to a remarkable degree, as most of the stimuli are constantly changing, and in a way very beneficial to us on the whole, as thereby our mind remains the freer. The light which regularly illumines every thing around us, the noise of surrounding objects, the air which we respire, all pass unnoticed by us, because we are accustomed to them; but as these stimuli become stronger, as for example, the light, or our own susceptibility increased, it dazzles us, or excites uneasiness. Our usual food and drink allay our hunger and thirst, but, happily for us, they produce no excessive excitement. Thus it is also with every thing else which we peaceably enjoy for any length of time.

But all things are, by continual repetition, so amalgamated with us, that they cannot be dispensed with; it is with these as with our health, or the enjoyment of beloved friends; it is only when we lose them, that we first feel how intimately they were connected with our comfort.

This happens in weak persons with the most trifling circumstances. They are also right to make every thing possible habitual with them, if their circumstances allow it. They may thereby arrive at a life long and undisturbed. Every one therefore, who finds any necessary object a difficulty, ought to be advised to accustom himself to the task. Thus, for example, a person who is subject to constipation, might, perhaps, accustom himself to an evacuation at a certain determined time.

The healthy, strong man, on the contrary, loses strength by the exercise of it; and whoever wishes to increase it for

a scientific purpose, ought not to accustom himself to exercise of any description; he thus becomes uniform, while the acquired activity would not compensate for the want of invention.

When people vary in their habits, they themselves generally alter. Man does not love that which he loved in childhood, because his constitution is changed. Not only his palate, but his stomach requires different nutriment. Thus we observe persons under disease forsaking many of their former habits. It is frequently very injurious, and we rejoice when we observe the patient returning to his former habits, as he then approximates more to his former condition.

Almost every person hits upon some particular stimulus, to which he finds it impossible to accustom himself, and this peculiarity is distinguished by the name of *idiosyncrasy*. Some particular flowers exhale an odour which is perhaps to us disagreeable, but is very grateful to others; particular kinds of food perhaps go against our inclination, excite vomiting or perspirations (as for example, the nettle-rash in some persons after eating crabs or muscles); particular medicines act injuriously on some persons, which act beneficially on people in general; and there are even those who cannot endure the sight of cats, spiders, &c. Much of this is owing to affectation or imagination, and I myself have witnessed a case, where the person pretended he could not by any means endure opium; he, however, used it under another name, and the effects of it were very beneficial; there are many cases, however, which are actually undissembled, and this is seen so much the more evidently, as such idiosyncrasies sometimes entirely disappear after a disease, as the person advances in years, &c.

Rem. If we compare in the above manner the effects of habit and idiosyncrasy together, and consider both as liable to change under cer-

tain circumstances, we will never be at a loss for the explanation of each particular case. When, for example, an habitual drunkard becomes intoxicated after drinking a little wine or spirits, it may at first appear rather paradoxical, and we would be inclined to think him able to stand the effects of very large quantities: but if we examine this circumstance more minutely, we will find, that these persons have, perhaps, accustomed themselves to the use of liquors, but then they have always been intoxicated by them, and thus they have impaired their powers; or they have perhaps been formerly able to bear it in larger quantities, but their nature has become altered with their age, and thus they are become unable for the task.

H. Dutrochet, *Nouvelle théorie de l'habitude et des sympathies*. Paris, 1810, 8vo.

CHAPTER IV.

OF THE TERMINATION OF LIFE.

239.

Every system contains within itself the germ of its own destruction, as all the organs of which it is composed become gradually more and more inadequate to their functions. The influence of stimuli diminishes, the parts to be stimulated become less susceptible, and thus the destruction of the whole is reciprocally effected. While, for example, the nerves of the digestive organs do not regularly support them, the food carried into the stomach is less accurately assimilated, and thus the nerves again are not satisfied; this state of things gradu-

ally increases, and becomes more general, until at last the whole becomes deranged. This decay, however, would proceed much more rapidly, if the functions of the body, during the time of the diminution of influence, did not act more gradually, so that their power is more slowly exhausted, and thus the compensation required, is, in like manner, less.

The life of man may, under favourable circumstances, be prolonged to the eightieth, ninetieth, or hundredth year. Thomas Parre, whom Harvey dissected, had attained the advanced age of 152 years, and after death, the cartilages of his ribs were found unossified; there are some cases on record, of a still more advanced age, but they are very few. The persons who have lived to this great age, were nearly all inhabitants of the northern or high countries, and almost universally of the labouring class of people, so that by exercise and a regular life, they had encouraged and sustained the uniform strength of their system. But besides this, they had certainly enjoyed, together with a peaceful and lively character, a happy constitution of body. For although it will be readily admitted, that persons in general may, by a life of moderate and regular exercise, arrive at a higher age than they do, it can, notwithstanding, by no means be asserted, that every person could by such means attain this remarkable number of years.

In people who die of senile debility (*Marasmus senilis*), all the powers are extinguished by degrees, and the symptoms of life are sometimes so indistinct that we are at a loss to know whether they actually live or not. I have seen a person die between 80 and 90 years of age, who had already been confined to bed for a long time, and had lain with his eyes shut for two days, and without any other motions than some slight convulsions in the legs, when they were brushed; he also expired without the least symptom.

Rem. 1. Numerous examples of the advanced age of men and animals may be found in Haller's Elem. Physiol. T. VIII. P. 2. p. 89—120.

In the lower classes of people the enumeration of their years is subject to a great variety of errors. They become forgetful, and consider themselves, without wishing to deceive, considerably older than they actually are, as they imagine that they themselves have oblived occurrences which they have only been told of in their youth. It often happens that they count by dozens or scores, an error in which makes a great difference.

Rem. 2. Gall formerly instituted a sign, viz. in the anterior section of the great occipital foramen, in order to determine the age at which any animal (or man) had arrived. In his later work, however, he has omitted it, and very properly, for as life is not connected with any particular part (212. *Rem. 4.*), neither, therefore, can any sign be found in one part of the length of its existence.

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Very limited is the number of those who attain an advanced age; of many thousands of persons there is scarcely one who reaches the hundredth year. Many children are still-born. Mortality is greatest at the first month after birth. It continues very great during the first year of life, diminishes a little during the following four years, and still more the years succeeding these, gradually decreasing with their number. Mortality is least general during the period of youth, and the first half of that of manhood, it then commences to become more frequent. In women the mortality at this time is not quite so great.

Of those, also, who die in old age, the death of the greatest number is occasioned by disease; and although the bills of mortality exhibit a numerous list of them dying from marasmus, dissection has proved the contrary, and we find very evident causes of death, as I can prove by experience.

Rem. Besides Bichat (207.), the following may be consulted as the best sources of information on the subject of death:

C. Himly, *Comm. mortis historiam, causas et signa sistens*. Gott. 1794, 4to.

Salom. Anschel, *Thanatologia*. Gott. 1795, 8vo.

C. G. Ontyd, *De morte et varia moriendi ratione*. L. B. 1797, 8vo.

On mortality, consult particularly the very valuable work of J. P. Süssmilch, *Die göttliche Ordnung in den Veränderungen des menschl. Geschlechts*. Berlin, 1765—76, 3 Bde. 8vo. The third part is executed by Chr. Jac. Baumann.

There is also much interesting matter in the article *Mortalité* by Friedländer in the *Dict. Méd.*

241.

From our life ought properly to be subtracted all the time which we must pass in sleep, in order to refresh the organs for a more active repetition of their functions; this happens in some organs by their action being completely suspended, in others by a less active operation of the same.

Besides this, some animals pass through a great part of the year in a continued state of torpidity, in a condition more or less resembling that of death, which state has been improperly denominated winter-sleep (*Somnus hybernus*), while it is much rather a state of torpidity (*torpor*), or suspended animation (*asphyxia*).

J. Chr. Fabricius (*Resultate naturhistorischer Vorlesungen*. Kiel. 1804, 8vo, S. 87.) considers that a similar circumstance frequently takes place in men; as he says, that we have many examples where men have been blocked up in the mountains of Liffland, and, after having remained unhurt for many months, have recovered, which, however, appears to be a sort of wintering. But this is by no means the case, for in all the examples of this accident which are known

to me, the persons remained completely awake and conscious of their situation; very interesting is, Ign. Somis, Ragionamento sopra il fatto avvenuto in Bergemoletto, in cui tre Donne sepolte fra le rovine delle stalle per la caduta d'una gran mole di neve, sono state trovate vive dopo trentasette giorni. Torino, 1758, 4to.,

The only distinction worthy of remark between the asphyxiæ of men and animals is this, that the latter can remain in this state for a very great length of time. Men who are sunk in snow may remain some days in a state of asphyxia; but of those who are brought into this state from the effects of water, there is scarcely one who is restored after having remained but a single hour; examples of such an occurrence are exceeding rare. I have not seen one case of restored animation, after the person having been in the water above half an hour. Persons have passed some days in a state of asphyxia resembling death; but how long it is possible to remain in this state, has not been determined; it is certainly not long, scarcely more than eight days; they have, however, never been accurately observed. The lower animals, on the contrary, may continue in this state during many months. They also awake from their asphyxia without much inconvenience, as I have myself witnessed in the marmot; in the human subject, on the contrary, asphyxia is followed by a disordered state of the system.

Rem. The narratives of persons being buried alive are certainly very much exaggerated, and in a great number of instances where the corpse has been found lying in a different position in the coffin from what it was put in, the grave-digger has no doubt robbed the coffin of its contents, and not taken the trouble to replace the corpse in its former position. My immortalized colleague Reil, related a case of this to me, which he had witnessed, where the grave-digger had, for a long time, been in the habit of taking away the bodies. This, however, is not sufficient to exculpate the detestable barbarity of committing any body to

the grave, before we have fully convinced ourselves of death having actually taken place, either by the preceding disease and injury, or by the commencement of putrefaction.

Jac. Baart de la Faille, *Diss. de Asphyxia*. Groning. 1817, 8vo.

Cph. W. Hufeland, *Ueber die Ungewissheit des Todes*. Weimar, 1791, 8vo.

Marcus Herz, *Ueber die frühe Beerdigung der Juden*. Berlin, 1788, 8vo.

J. P. Frank's *Medicinische Policei*. Fünfter Band. Tüb. 1813, 8vo.

242.

Of the many occurrences of suspended animation in the human subject, we have as yet received no explanation; this however, appears to be possible to a certain extent, from observations on those animals which are rendered torpid during the winter. I shall therefore go briefly through the principal points of it.

We find great numbers of animals among the tribe of mammalia, which pass the winter in a state of torpidity, and particularly the rodentia, as the marmot, hamster, myoxi, erinaceus, bat, and also, sometimes at least, the badger and bear. These animals sometimes lay up a greater, sometimes a smaller quantity of winter provisions, with which they shut themselves up in their holes, lest they should awake and not be able to find food, as is the case with the bear.

That cold is the principal inducing cause of torpidity, is shewn by Pallas (*Reise*, 1. Th. S. 154.) and Prunelle (in the dissertation mentioned below), who found them in the same condition during the summer in ice-caves. The cold ought not, however, to be too severe, for in that case they awake, feel uncomfortable, and can no longer protect themselves against its influence, and consequently die. In their winter-holes they are always protected by hay, by cohabitation,

&c. The heart acts, but very feebly ; respiration also never entirely ceases, but is very slow, so that there are very few (three or four) inspirations in the course of a minute ; they therefore respire the oxygen of the atmosphere, although more gradually, and also die in carbonic acid gas, although more slowly than when awake. They possess very little sensibility and irritability, so that mechanical stimuli have very little effect on them ; galvanism, on the contrary, arouses them very quickly ; this happens in general according to the degree of their torpidity. Twelve marmots were sent to me in a chest from Tyrol, most of which (probably awakened and killed by the cold) were in a state of putrefaction, while the remainder lay torpid and unhurt. Putrefaction had made no impression on these ; they awoke soon afterwards, became again torpid, &c.

We have not found that there is any structure which can be said to be peculiar to torpid animals. It is true that the omentum of these animals is very great, as for instance, that of the bear ; or they possess, besides this, lateral ones, as in the marmot, in all of which there is a great quantity of fat deposited ; they have large adipose glands on the neck and breast, which have sometimes been confounded with the thymus ; they have besides a great quantity of fat, but this is only an assistance to them, and is consumed during their continuance in this state ; it is by no means the cause of torpidity. There are also other animals which do not become torpid, viz. the birds, which pass the winter with us, and are on the whole as if laden with fat. A peculiar arrangement of the vessels of the head (as Mangili insists) can much less be considered as a cause of it ; for many animals very nearly allied to them, and of an exactly similar structure, are not at all subject to it, as, for example, common mice ; and on the other hand, there are animals which become torpid, belonging to other classes, and of quite a different structure ; torpid

manials can also, under favourable circumstances, viz. under the protection of man, wean themselves from it.

Thus it is only to be considered a susceptibility possessed by some animals, given to them for the sake of their preservation against certain degrees of cold, which benumbs them, together with a capability of sustaining life under a diminished vital action. But should reproduction cease entirely, they die.

We may thence infer, that in people who have, during disease, lain a long time as if dead, and again recovered, the process of respiration and circulation have, in like manner, not been entirely suspended; the circumstances might also be something similar in those who have been found benumbed in snow, and afterwards saved. In those who have lain in water, however, the circulation and respiration are completely obstructed, and thus the shortness of the time which will admit the possibility of resuscitation. According to the observations made on torpid animals, it is probable that the galvanic stimulus might be the most efficacious means to be employed for the purpose of resuscitation, but of course, in an adequate degree of strength.

Rem. 1. Among birds, the swallow is the only one which passes into the state of torpidity, but this, again, is so much disputed, that a book might very easily be written by collecting all that has been said on this subject. That they could pass the winter completely covered over with mud and water, scarcely any one will be inclined to believe, who has witnessed the torpid state of animals; nor can any one explain how they will be able to recover their respiration when the spring has arrived, while they remain buried among mud and water. On the contrary, it may be admitted that they secrete themselves on the shore, where some of them, under favourable circumstances, undergo some diminution in their vital functions, and recover again in spring, while the rest of them die. This, however, is by no means general, as is shewn by the transmigration of swallows. To confirm this proposition, it is necessary to

be acquainted with swallows, which are much more tenacious of life than other birds. Very instructive is the dissertation of J. Gottl. Leidenfroft, *De lethargo Hirundinis*. Duisb. 1758, 4to.

Rem. 2. Torpidity is known to take place in very many amphibia, viz. the tortoise, lizard, snake, salamander, and frog. C. Robin denies that it takes place in the crocodile, but unless he has observed them in southern countries, his assertion is of no moment. Tiedemann wrote to me two years ago that he had a young crocodile (*Crocodilus Lucius*) in a state of torpidity.—Very wonderful indeed is the circumstance related by Humboldt (*Reise*, 3. S. 328.) of torpidity taking place in the crocodile during the summer, but Sonnerat (*Reise nach Ostindien und China*, 2. B. S. 115.) mentions a somewhat similar circumstance of the *Erinauceus ecaudatus*, in Madagascar, viz. that it buried itself in the earth, and slept during three months of the year.

In other respects the amphibia are likewise not necessarily subjected to this torpor; I have frequently, during the winter, been able to obtain the proteus, water-salamander, frogs, and toads, in a very lively condition; lizards also (*Lacerta viridis* and *agilis*) remain quite free from torpidity, but are more dull and drowsy; the former are probably better from being in the water, and are thereby rendered more lively than those which are dry, when they are both equally without food.

Further, it is in animals of this class that the most striking examples of asphyxia have been observed, particularly if we enumerate with these, the cases where toads have been found to outlive the circumstance of having been shut up in stones.

Rem. 3. Torpidity is very common among fishes during the winter, sometimes in those which live in fresh water, vide 182., where I have cited examples from Buniva, Pallas, and Bell; we may refer hereto what Otto Fabricius (*Fauna Groenl.* p. 177.) has said of the *salmo rivalis*; this probably takes place also in fishes which live in mud on the shallow sea-shores, as the sea-horse, *syngnathus hippocampus*, the torpidity of which has been observed by Rusconi (*Giorn. di Brugnategli*, 1819, p. 77—82.).

Rem. 4. Among insects two kinds of torpidity takes place. In the first place, it may be observed, that a great many of them lie in the

earth, under the bark of trees, stones, &c., and although Reeve asserts that they are destitute of fat, no one, I think, will be inclined to support him. We might also enumerate with these the *Chrysalis*, in which a metamorphosis gradually goes on, although they do not eat. In the second place, we must explain the falling down of so many of the beetle kind, as the *cryptocephalus*, *buprestes*, *elater*, *dermestes*, &c. as a short continued asphyxia. It was formerly generally considered to be a dissimulation, but this it certainly is not; and if we cannot explain it as a state of torpidity, we must content ourselves with ascribing it to instinct, for it is not in their power to remain so long in this state as it is necessary, but they always fall back again if they are roused.

Rem. 5. Lastly, it may be observed, that torpidity certainly takes place in worms. But this circumstance, like every thing else, is greatly exaggerated.

It was formerly contended, that moss, when dried and never so old, if put into water again, acquired life; but softening with water, and restoring to life, are two different things; it has only been soaked, and never again dried for a long time, thus, instead of growing, it has putrified. The drying of worms, as the *Gordius*, *entozoa*, and *infusoria*, infallibly kills them, and their re-animation is a fiction, which one relates on the authority of another. Exsiccation puts a complete stop to the whole organisation. Frogs which have been frozen, again recover animation, as has been proved by Anschel (*Thanatol*, p. 21.) by experiments on forty individuals; but a frog which is once dried, however short the time, never again becomes re-animated.

Rem. 6. For the more ancient literature on this subject, I refer the reader to Krünitz in the *Hamb. Mag. B. 26. S. 419—427.*, and in the new *Hamb. Mag. B. 5. S. 95.*

F. G. Sulzer, *Versuch einer Naturgeschichte des Hamster's*. Gött. 1774, 8vo, S. 162—176.

Mangili, *Mém sur la Lethargie des Marmottes*. *Ann. du Mus.* 9. p. 106—117. *Mém sur la Lethargie périodique de quelques Mammifères*. ib. 10. p. 434—465. *Journ. de Physique*, 1818. Jul. p. 160.

M. J. A. Saissy, *Recherches expérimentales sur la physique des animaux mammifères hybernans*. Paris et Lyon. 8vo. †

Henry Reeve, *An Essay on the torpidity of animals*. Lond. 1809, 8vo.

Prunelle, *Recherches sur les phénomènes et sur les causes du sommeil hivernal de quelques mammifères*. Ann. du Mus. 18. p. 20—56. Second mémoire, ib. p. 302—321.

Ludwig Jacobson, *Ueber die Thymus der Winterschläfer*. Meckel's Arch. 3. S. 151—154.

243.

Many authors have believed that there are certain parts which have the power of retaining life, when its general bonds are suspended, and they have, on this account, had recourse to plants as well as animals.

In vegetables, the homogeneousness of their parts is so great, that many of them may indeed exist and grow independent of the rest, as is more particularly observed in succulent vegetables, in which perfect vegetables may arise from single leaves. We find also, that in trees which have been hewn down or engrafted, all the juice which is present, and intended for the developement of the leaf or flower-buds, which have already appeared, is turned off, until at length the exhausted plant sinks.

The same may be observed of polypi, naides, and other homogeneous worms, whose bodies may not only be divided into parts without destroying life, but each part takes on an independent existence.

Further than this no circumstance of the kind is observed, although insects are extremely tenacious of life. I once found (in Franconia, on the 30th June, 1795,) a *Curculio sulcirostris*, in the body of which was a large lateral cavity, in which I found three ants; a great part of its trunk (above one-half), and a part of the covering of its wings were destroyed, and notwithstanding these it continued to croak very calmly. Schüppel related to me the case of an *Akis acuminata*, which he shewed me, viz. that a French entomologist had spitted it

in Spain in the month of November, and brought it to Berlin, and that it still lived on the needle in March, and moved its feet. This is certainly a great deal. But deprive an insect of the head, or separate the breast from the trunk, and the life is soon completely extinguished ; and although in some, the feet, when separated from the body, may still move, it cannot be considered as any thing more than convulsive movements of the muscles.

How then can it be thought possible, that in man, the most complicated of all created beings, the life of the parts could remain when the re-action of the parts had ceased, which reciprocally sustain the life of each other? And yet the most distinguished characters have admitted and believed, that when the head of a man is separated from his trunk, life and sensation remain in the other parts of his body. We know also, that when the spinal marrow of animals is cut through, death instantaneously follows, and the animal drops without a single struggle ; and in man the same thing must take place. How also can it be possible that a cerebral action should remain, when the blood has streamed from the largest vessels, and the brain completely collapsed, when even a full bleeding from a vein in the arm so easily deprives a person of his senses. Clossius indeed, p. 11, says, that there is always blood on the brain ; this may be the case, but it is not in action, and consequently affords no stimulus. Those symptoms which have been viewed as the signs of life, have been nothing more than convulsions of the muscles which have been provoked by mechanical or galvanic stimuli. The fable related of Charlotte Cordé, whose head, when struck off, is said to have blushed from a blow on the cheek given by the executioner, can only be explained by some sort of change having taken place on the surface of the skin ; for a determination of blood to the superficial vessels of the cheek, no one in his senses can admit.

Thus therefore, when death by hanging is good-naturedly recommended in preference to the axe or the sword, there is throughout nothing gained by it. In the experiments instituted by Ure and Jeffray on the body of a murderer who had hung an hour on the gallows, the muscular movements were stronger than they had ever observed in any person beheaded. There is perhaps no kind of death after which it is impossible that the same thing should take place, provided the galvanic stimulus be soon enough applied. I have either read somewhere or heard, that the muscular motion of an eel is completely destroyed if its head be struck with great force against a stone; I have tried this a few times, but found that the muscles were afterwards convulsed, as otherwise happens.

The fulness of the absorbent vessels, as found after death, will be treated in detail under the doctrine of absorption; this is just as like a vital absorption, as it is a vital secretion by means of which the collections of water found in the ventricles of the brain are occasioned, &c.

In older writers an erroneous belief obtained that the nails and beard of the human subject continued to grow after death; and that it has something of the appearance of this must readily be admitted, for at this time the external skin contracts, and thus the above-mentioned parts become more and more exposed. This, however, is no growth. To effect a growth of any part belongs to the vitality of the system; and for the purpose of supporting the growth of the hair, and supplying its nutriment, vessels and nerves are situated within its bulb, and when these cease to act, the hair immediately dies and falls off, even from the living body. But the growth of the nails is still more conditional, and their reproduction consequently more difficult. How then is it possible that these parts can increase after death, when they are deprived of both vessels and nerves? They rescue themselves from this dilemma with a word, and reply,

they vegetate; but is this being deprived of life? If it had been said that they were elongated after death by the moisture, then there might at least have been some reason in it; but this likewise would have been equally erroneous, for the horny substance never extends after death. But who are they who have seen such things take place? Females, and the weak-minded and credulous, to whom a beard may very easily appear too long. Such a circumstance has never been observed by the physician or naturalist, for the example of Pareus is in vain applied to such a case. How many mummies have been investigated, how many corpses are dissected yearly, and still this elongation has never been remarked!

Rem. No one will think it at all strange that Schubert (*Ahnungen einer allgemeinen Geschichte des Lebens*. Lpz. 1806, 7. 2. B. 1. S. 63.) should incline to the belief in the growth of hair after death, who is aware of his propensity to the mystical and wonderful, by which his talents have not been applied to the advantage of science. It is probably he who has misled C. Gust. Carus (*Versuch einer Darstellung des Nervensystems*. Lpz. 1814, 4to, S. 39.), when he speaks of the *remarkable growth of nails and hair after death*.

Lettre du Prof. Soemmerring, sur le supplice de la Guillotine. In *Mémoires de la soc. d'émul.* P. 1. p. 266—277. Note sur l'opinion d. M. M. Oelsner, Soemmerring et Sue touchant le supplice de la Guillotine. Par P. J. G. Cabanis. *ib.* p. 278—293.—Dissertation physiologique etc., par J. B. F. Lévillé. *ib.* p. 293—301. (Both against S.)

J. J. Sue, *Recherches physiologiques sur la vitalité*. Paris, an 6. 8vo. †
C. Fr. Clossius, *Ueber die Enthauptung*. Tüb. 1797, 8vo. (with S.)

C. A. Eschenmayer, *Ueber die Enthauptung*. Against the opinion of Soemmerring. Tüb. 1797, 8vo.

J. Wendt, *Ueber Enthauptung im Allgemeinen und über die Hinrichtung Troer's insbesondere*. Breslau, 1803, 8vo. (On the side of S.)

Aug. Theod. Zedig, *Beweis dass ein vom Rumpfe getrennter Kopf sogleich das Bewusstseyn verliere*. Bresl. 1803, 8vo.

Exposé de quelques expériences faites sur le corps d'un supplicié immédiatement après son exécution; suivi d'obss. physiologiques et pra-

tiques; lu à la soc. litt. de Glasgow, 1818. Bibliothèque universelle. Fevr. 1819, 8vo, p. 128—136.

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We might here mention those movements which take place in the muscles after death, effected by the operation of various stimuli, but particularly by galvanism; in order to avoid repetition, however, I shall refer the reader to the Special Physiology, and will only remark in this place, that these movements do not only take place in entire members or individual muscles, but even in small parts of these from which the blood has previously been pressed out; which circumstance sufficiently proves, that it is only a peculiarity in the muscular fibre, and by no means the effect of life being restored to the muscles.

The chemical changes which the animal body undergoes after death, are contained in the last chapter of the third Book.

Rem. A mouldiness (*Mucedo*) has been lately supposed to take place in the living body, but this can in no respect be credited. A. C. Mayer (Verschimmelung, *Mucedo*, im lebenden Körper. Meckel's Arch. 1. S. 310—312.) found the lungs of a *Corvus glandarius*, which had died the night before, covered with a byssus, and believes that this had existed during the life of the animal, without, however, mentioning the time of the year, the moisture of the air, the place where the animal had lain, and the time which had elapsed before dissection. G. F. Jäger (Ueber die Entstehung des Schimmels im Innern des thierischen Körpers. l. c. 2. S. 354—356.) very properly doubts the truth of this assertion. He has observed the same thing take place in a swan very soon after death, but found that it also extended to many other parts. That such parts, however, moulder before others, is shewn by the morbid state of these parts, which are known more quickly to undergo putrefaction (205.). The conditions necessary to the production of mould are never found in the living animal, and least of all in the bird.



